

Three New
Packages

integrated laboratory packages for teaching & research volume five



Qubit
systems

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*The scientists on the staff of **Qubit Systems** will be delighted to provide whatever assistance you may require in planning your experiments for teaching or research.*

Contact: **Qubit Systems Inc.**, 4000 Bath Road, 2nd Floor
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company profile

Recent advances in sensor technology have made it possible to monitor atmospheric gases and biological processes with an accuracy and affordability that were inconceivable only a few years ago.

Qubit Systems Inc. has incorporated these technologies into a range of high quality, integrated products for teaching and research in the biological sciences.



The Qubit staff are experts in their fields and are happy to provide help with any questions that you may have.

The educational arm of Qubit Systems concentrates on giving university undergraduate students much needed hands-on experience in collecting and manipulating experimental data. Qubit Systems has developed educational packages that offer:

- inexpensive, state-of-the-art sensors
- real-time data collection directly to a PC or Mac
- full documentation for instructors and students

A Qubit Systems educational laboratory package includes everything the students need to conduct experiments to illustrate important biological principles, or for self-directed original research.

The research arm of Qubit Systems concentrates on pushing the limits of gas detection technology. Current research products include a differential oxygen analyzer that offers up to five times the sensitivity of competing analyzers, a convenient gas analysis bench for CO₂ and O₂ measurements and a family of gas sensors for industrial use.

Qubit Systems was founded as a spin-off company from Queen's University. In fact, the Qubit name stands for "Queen's University Biological Instrumentation and Technology". Qubit operates within the Kingston community and retains links with the university to test its products.

If you would like to place an order, or if you require further information, you can contact us at:

Qubit Systems Inc.

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Kingston, Ontario
Canada K7M 4Y4

Toll free: **1-888-262-2219** (North America)

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Qubit
systems



product quality

Our clients

Qubit Systems' products are currently in use at over 800 institutions in 50 countries.

Our clients include:

Agriculture and Agri-Food Canada
 Australian National University
 Awassa College of Agriculture, Ethiopia
 Bamfield Marine Station, British Columbia
 California State University, Stanislaus
 Centre for International Environment, Norway
 Dole Pineapple, Costa Rica
 Genius Chemical Company, Taiwan
 High Altitude Plant Physiology Research Centre, India
 Institut National d'Horticulture, France
 Iowa State University
 Kansas State University
 Lincoln University, New Zealand
 Max Plank Institut, Germany
 McGill University, Quebec
 Ohio State University
 Oklahoma State University
 P.S. Instruments, Czech Republic
 Texas A & M University
 Universidad de Chile, Chile
 Universidad de Puerto Rico
 Universität Koblenz, Germany
 Universität Landau, Germany
 Université de Montréal, Québec
 Université de la Réunion, France
 University Nacional Autonoma de Mexico
 University of Basel, Switzerland
 University of California at Davis
 University of Central Queensland, Australia
 University of Copenhagen, Denmark
 University of Delaware
 University of Florida

University of Kalmar, Sweden
 University of Manchester, Great Britain
 University of Tasmania, Australia
 University of Tennessee
 University of Toronto, Ontario
 University of Vienna, Austria
 University of Waikato, New Zealand
 University of Western Australia
 USDA Agricultural Research Service, Iowa
 Victoria University of Wellington, New Zealand

It's guaranteed!

Qubit stands behind its product quality with confidence. We offer excellent customer service and would be happy to help you with any questions you may have. All of our products are fully guaranteed for two years. Please be assured that should you decide to return any of our products within 30 days, we will refund your money in full, including shipping charges.

word of mouth

"I have found the people at Qubit Systems to be an extremely valuable resource in getting three different systems up and running. Their knowledge, experience and unfailing good humor helped me work through a number of issues. They have provided the best service that I have ever received from a company."

Dr. Diane C. Robertson
 Biology Department
 Grinnell College
 Grinnell, Iowa



Qubit
 systems

low range and high range respiration packages

The concept

Cost and animal welfare concerns are two of the greatest impediments to teaching animal physiology effectively. To address these concerns, Qubit Systems has developed inexpensive but extremely accurate sensors and equipment for non-invasive, real-time monitoring of animal gas exchange.

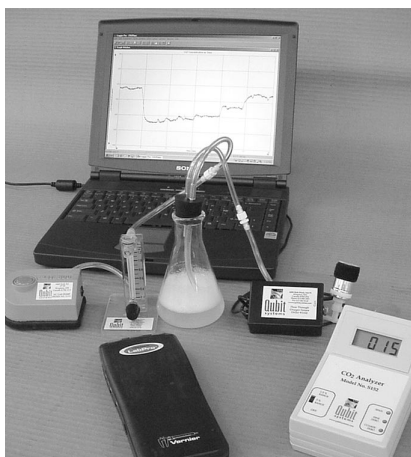
You can use our custom **Respiration Packages** to study small mammals, reptiles, amphibians, insects and other invertebrates, soil, and even colonies of fungi and microorganisms. Qubit Systems' gas exchange technology is inexpensive enough for your teaching laboratory, yet it has the sensitivity and accuracy required for many research applications. It is also sold at a fraction of the cost of most research instrumentation.

With Qubit's Respiration Packages, you can:

- compare the metabolic rates of different organisms
- determine metabolic rate during sleep and various levels of activity
- investigate the effect of temperature on metabolism
- observe the metabolic effects of pharmaceuticals and special diets
- conduct investigations in equilibrium biochemistry and energy balance
- examine the effect of diet on respiratory exchange ratio

There are many other potential applications for Qubit's Respiration Packages. You can use our equipment to examine:

- respiration or fermentation in a yeast suspension
- respiration in aqueous and plated cell cultures
- respiratory fluxes from microorganisms living in soil
- respiration of root systems



Yeast Respirometry System

In fact, our equipment can be used to measure the O_2 consumption and CO_2 production of almost any biological system. For aqueous systems, an Erlenmeyer flask may be used as the sample chamber. A flask stopper with special fittings is provided with both Respiration Packages.

To determine O_2 uptake in very small organisms and organisms with very low metabolic rates, the O_2 sensor can be incorporated directly into a sealed sample chamber. Metabolic rate may then be calculated from the rate of O_2 depletion.

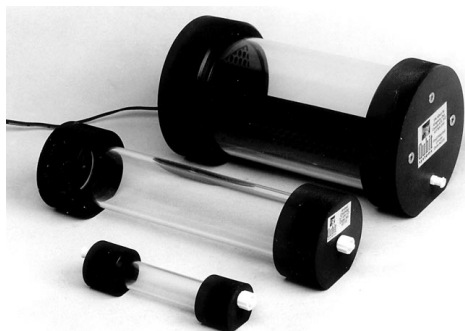
Procedure

The components of the Respiration Package are configured in an open-flow gas exchange system. The Logger Pro software supplied with the Respiration Package allows up to four variables to be monitored simultaneously.



Qubit
systems

Data from the O_2 Sensor, Infra Red CO_2 analyzer and Temperature Sensor (or optional environmental sensors) are displayed on-screen immediately as they are collected. This allows students to observe changes in an organism's O_2 uptake and CO_2 output as it responds to altered environmental conditions. Logger Pro's sophisticated data-handling features enable students to analyse and graph the stored data easily.



Animal Chambers

Experiments

The following experiments are documented in our Student's and Instructor's Manuals:

- measurement of the metabolic rates of a cricket and a mouse
- the effect of temperature on the metabolic rates of an endotherm and an ectotherm
- measurement of aerobic respiration rate in a yeast suspension
- measurement of fermentation rate in a yeast suspension

Both packages include:

- Infra Red CO_2 Analyzer
- Flow-Through O_2 Sensor
- Temperature Sensor
- at least one Animal Chamber
- AC Gas Pump
- Flow Meter with needle valve

- Gas Bags
- 4-channel interface and software
- Instructor's Manual with CD
- Student's Manual with CD

The Low-Range Respiration Package

If you wish to study small organisms or organisms with low metabolic rates, you will require the Low-Range Respiration Package which includes the S151 CO_2 Analyzer. This analyzer has switchable ranges between 0-500 ppm and 0-2000 ppm CO_2 . 2cm- and 3.7cm-diameter Animal Chambers are supplied with the package. The chambers are available in custom lengths. Each chamber has a built-in port to accommodate a temperature sensor.

The High-range Respiration Package

If you wish to study mammals, other larger animals, and animals with higher metabolic rates, you will require the High-Range Respiration Package which includes the S153 CO_2 Analyzer with switchable ranges between 0-5% and 0-10% CO_2 . If you prefer, you may substitute the S152 CO_2 Analyzer with switchable ranges between 0-1.5% and 0-3% CO_2 . An 8.5cm diameter animal chamber is supplied with this package. The chamber includes a fan, which ensures that the air within the chamber is well mixed.

word of mouth

"We purchased twenty Respiration Packages with support from the Howard Hughes Medical Institute. With minimal training, all 150 student teams were able to measure the effects of temperature on respiration rates in mice and lizards. The Qubit Respiration Package certainly works as advertised."

Dr. Bob Hodson
Department of Biological Sciences
University of Delaware
Newark, Delaware



Animal Respirometry System

Optional additions to the High-Range Respiration Package

If you have the High-Range Respiration Package, you can assemble a complete Human Physiology Package by purchasing the following items:

- Breath-Collection Valve Assembly (G221)
- Breath-Collection Bags (G124)
- Breathing Monitor Belt (G224)
- Absolute Pressure Sensor (S181)
- Wireless Exercise Heart Rate Monitor (S182)
- Human Physiology Student's and Instructor's Manuals (M/C 951& 952)

Optional additions to the Low-Range Respiration Package

If you have the Low-Range Respiration Package, you can measure photosynthesis, photorespiration and respiration in leaves by purchasing the following items:

- Flow-Through Leaf Chamber (G112)
- Laboratory Stand (A101)
- LED Light Source (A113)
- or Halogen Light Source (A111)
- Light Sensor (S141)

To purchase

Low-Range Respiration Package

Order #: RP1LP

Price: \$1925 US

High-Range Respiration Package

Order #: RP2LP

Price: \$2295 US

All system components may be ordered individually. Please consult the Product Line and Price List at the end of catalogue.

human physiology package

The concept

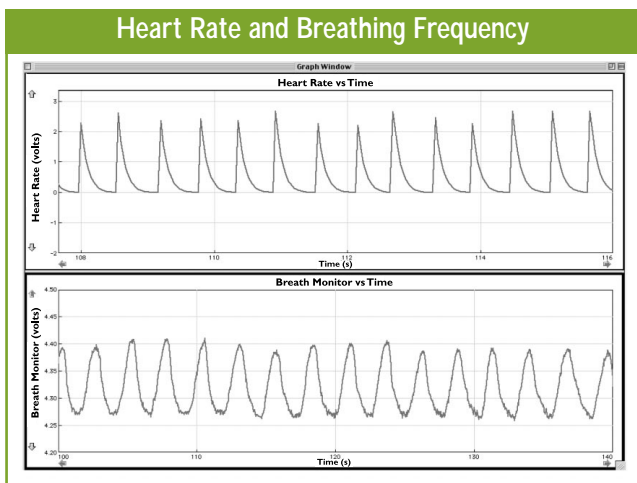
Qubit's **Human Physiology Package** allows students to conduct numerous safe, exciting investigations in respiratory and cardiovascular physiology. The equipment and instruments are simple to set up and operate and the experiments are interesting and informative. The Human Physiology Package is inexpensive enough to be purchased in quantity for use at undergraduate laboratory stations, yet the package's Infra Red CO₂ Analyzer, Oxygen Sensor and Wireless Exercise Heart-Rate Monitor have the accuracy and resolution required for advanced student research projects.

Using the equipment in the package, students can monitor heart rate, breathing frequency, and relative breathing depth, and measure the CO₂ and O₂ concentration of inhaled and exhaled air. They can then calculate tidal

volume, minute volume (VE), oxygen uptake (VO₂), and carbon dioxide output (VCO₂). The Logger Pro software supplied with the package displays the heart rate, breathing frequency and relative breathing depth signals of the subject on-screen as they are collected. This allows the students to observe changes in these variables immediately as they occur. Logger Pro also permits sophisticated analysis of the stored data files.

Procedure

The Wireless Exercise Heart Rate Monitor uses a Polar electrode and transmitter/receiver system to transfer heart rate data to the Lab Pro Interface. The absence of messy, stick-on electrodes and cumbersome leads allows the subject great ease of movement and virtually eliminates motion artifacts.



Qubit
systems

Breathing frequency and relative breathing depth are monitored using the Breathing Monitor Belt with its Absolute Pressure Sensor. The pressure in the belt's air-filled bladder decreases during exhalation and increases during inhalation. These pressure changes are detected by the Absolute Pressure Sensor and transmitted to the Lab Pro Interface.



Wireless Exercise Heart Rate Monitor

At appropriate times during an experiment, a breath collection bag is attached to the valve assembly for a specified number of exhalations. Unlike Douglas Bags, our breath-collection bags are light weight and easy to handle. They are supplied complete with connectors which attach securely to the valve assembly.

The exhaled air collected in each bag is pumped through the gas analysis system at a known flow rate to obtain end-tidal pO_2 ,



Breathing Monitor

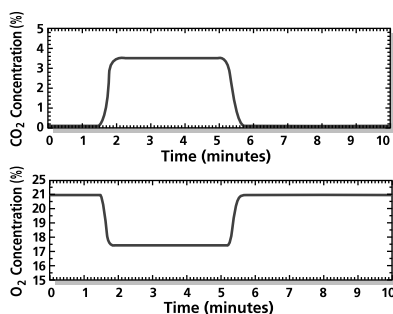
end-tidal pCO_2 and bag volume. Room air is then pumped through the gas analysis system to determine inhaled pO_2 and pCO_2 values. The gas analysis system is simple to set up. Each component is supplied with inflow and outflow tubing and twist-on, luer connectors to facilitate rapid, leak-free assembly.

Experiments

Numerous experiments may be conducted using the instruments and equipment provided with the Human Physiology Package. The following investigations are documented in our Student's and Instructor's Manuals:

- effects of hyperventilation and breath holding on respiration and heart rate
- effects of isotonic exercise on respiration and heart rate in a trained and an untrained subject
- effects of rebreathing and increased dead space on respiration and heart rate
- effects of isotonic exercise on VE , VO_2 , VCO_2 and respiratory exchange ratio

Breath Analysis



Analysis of O_2 and CO_2 in exhaled breath

Full experimental protocols are provided together with background information, data-analysis instructions and blank tables. All of the experiments described in the student's and instructor's manuals can be completed within a three-hour laboratory period.



The package includes

- Infra Red CO₂ Analyzer (0-10% range)
- O₂ Sensor (0-100% range)
- Breathing Monitor Belt with Absolute Pressure Sensor
- Wireless Exercise Heart Rate Monitor
- AC Gas Pump
- Breath-Collection Bags
- Breath-Collection Valve Assembly with mouthpieces
- Flow Meter with control valve
- 4 Channel Lab Pro Interface
- Logger Pro Software
- Instructor's Manual with CD
- Student's Manual with CD

Field data collection

With the addition of Qubit's battery pack and charger (A242) and a DC pump (G103), the Human Physiology package is portable. You can analyze air in breath-collection bags at remote locations. You can also collect heart rate data from subjects as they undertake everyday activities at work or participate in some outdoor sports. Our equipment is inexpensive, light-weight, durable and simple to use. The Lab Pro interface can be battery powered for use as a stand alone data collection device. Data can be downloaded to a computer later.

Fitness testing

You can easily determine the aerobic fitness of normal, healthy subjects using standard testing protocols and the equipment supplied with this package. The Human Physiology Package is ideal for use by athletic trainers and fitness specialists at health clubs, training camps and university athletic departments.

Ambient humidity and temperature monitoring option

Qubit's Humidity and Temperature Sensor (S161) with the AC Pump (G101) are ideal for tracking ambient temperature and humidity levels in your environmental chamber. Using the four-channel data acquisition system supplied with the package, you can monitor changes in temperature and humidity and the resulting effects on a subject's breathing frequency and heart rate.

Animal respiration option

You can own all of the components of both our Respiration and Human Physiology Packages by ordering the Human Physiology Package, the 8.5 cm-diameter Animal Chamber (G114), the Temperature Sensor (S131), and the Respiration Instructor's and Student's manuals (MC891/892).

Note: The equipment and instruments supplied with the Human Physiology package are not approved for medical diagnostic purposes.

To purchase

Order #: HP1

Price: \$ 2425 US

All system components may be ordered individually. Please consult the Product Line and Price List.



human electrophysiology measurement

The concept

Qubit Systems latest series of sensors are designed to investigate electrophysiological aspects of human physiology in a completely safe and non-invasive manner. Disposable electrodes are supplied, each of which has a gel backing that attaches the electrode to the subject's skin. Signals from the skin are transmitted through optically isolated circuitry, and power for the sensors is transformed from AC to low voltage DC, so there is never any risk of electric shock.

Numerous investigations are possible with each of the sensors, which may be purchased individually or as a package with a Lab Pro interface and Logger Pro software. (Because of its maximum sample rate of 50 points per second, the sensors will not operate with Data Logger software and the Serial Box interface). The sensors provide an excellent complement to the Human Physiology Package for comprehensive investigations of subjects under a variety of conditions.

NOTE: *All human electrophysiology and human respiratory monitoring products provided by Qubit Systems Inc. are not appropriate for medical or clinical applications.*

The Human Electrophysiology Package

The package includes:

- *Electrocardiograph Sensor*
- *Electromyograph Sensor*
- *Hand Dynamometer*
- *Galvanic Skin Response Sensor*
- *Electrooculograph sensor*
- *Disposable Electrophysiology Electrodes*
- *Instructor's Manual*
- *Student's Manual*
- *Lab Pro Interface*
- *Logger Pro Software*

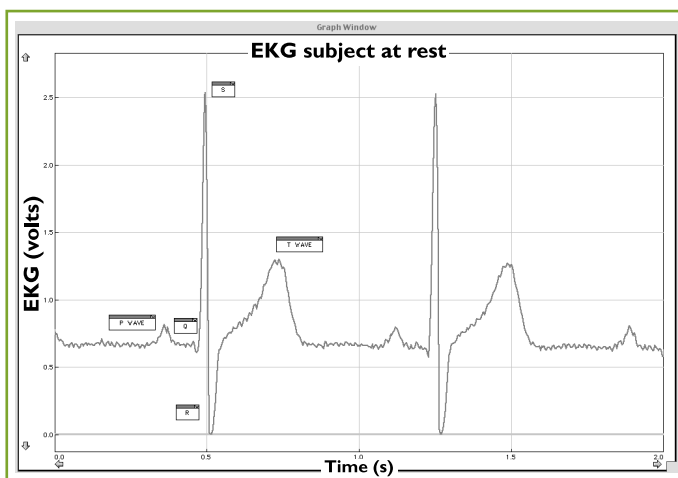
To purchase

Human Electrophysiology Package

Order #: HE1LP

Price: \$2850 US





Output from EKG sensor showing two heart cycles

EKG Sensor

The EKG sensor measures cardiac waveforms generated by electrical activity of the heart muscle. The cyclical contraction and relaxation of the atria and ventricles involves polarisation and depolarisation of heart muscle fibres. This creates an electrical current that moves through the body, and which can be measured by electrodes attached to the skin.

The subject should be stationary when making the measurements, but interesting comparative data may be collected before and after exercise. Other interesting investigations involve placing the electrodes at different places on the body to determine the axis of the heart, and studying the change in the waveforms before and after the ingestion of mild stimulants (e.g. caffeinated coffee or cola).

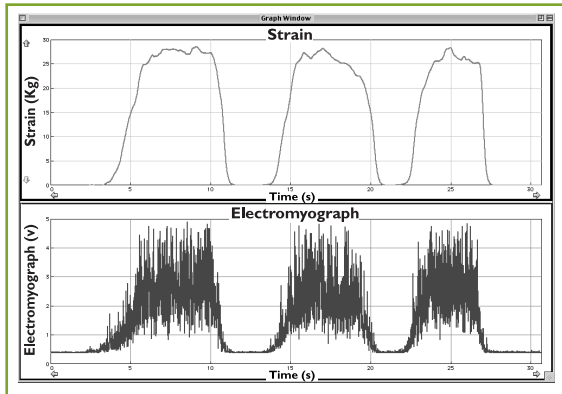
The EKG sensor is supplied with 3 electrode cables, a set of 100 disposable electrodes, an AC/DC transformer and a laboratory manual describing the source of the electrical signals and various experiments that can be conducted with the sensor. The sensor must be used with the Lab Pro Interface and Logger Pro software.

To purchase

EKG Sensor

Order #: \$205

Price: \$375 US



Simultaneous measurement of output from the hand dynamometer (upper graph) and the rectified signal from the EMG (lower graph)

EMG Sensor and Dynamometer

Qubit Systems' surface electromyograph (EMG) sensor records the electrical activity of muscles. Normal muscle tissue is electrically silent when relaxed, but when it is active during a contraction an electrical current is generated that may be measured at the surface of the skin. The strength of the signal is dependent on the number of muscle motor units that are recruited to contract the muscle. Thus, with a strenuous contraction a greater signal is measured. Using Lab Pro and Logger Pro software a recorded waveform of the electrical signal (called an electromyogram) is shown on the computer screen, and may be analysed using Logger Pro's "Zoom In" features and data analysis capabilities. Either the raw data may be collected from the EMG sensor, or data that is rectified for easier analysis.

During experiments, an audible signal is produced as the muscle is flexed so that the student receives both a visual and aural indication of the strength of the contraction. Both stimuli may be used by the student to control the contraction of the muscle and the number of motor units recruited. In addition, the EMG may be used to study involuntary muscle

movement such as that involved in the patellar tendon ("knee jerk") reaction.

Qubit System's Hand Dynamometer may be used with Lab Pro in a variety of experiments, or may be combined with the EMG sensor for comprehensive studies of muscle activity. The dynamometer is factory calibrated in Kg. It measures grip strength, relative strength of the left and right hand, muscle fatigue and endurance. Its sensitivity ensures that all students may obtain excellent signals, and may participate in the full complement of studies. A favourite investigation involves the control of grip strength in which students attempt to obtain repeated measurements of the same magnitude. By changing frequency of repetition, muscle control and endurance may be studied. Coupled with EMG measurements, this provides a very informative and entertaining laboratory session.

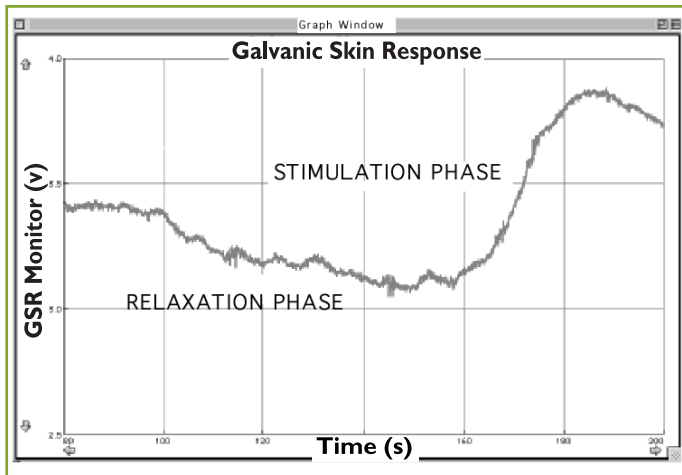
To purchase

EMG Sensor
Order #: S210
Price: \$590 US

Hand Dynamometer
Order # S215
Price \$350 US



Qubit
systems



*Output from the GSR sensor during a relaxation phase (eyes closed)
and a stimulation phase (eyes open)*

GSR Sensor

Qubit Systems' galvanic skin response (GSR) sensor measures the psychogalvanic reflex. This reflex results in a change in the conductivity of the skin during periods of stress, excitement or shock. Under these conditions skin conductivity increases, whereas during periods of relaxation conductivity declines to a minimum. The GSR sensor monitors skin conductivity between two electrodes that are attached to two fingers of one hand. While the subject is at rest a steady background signal is obtained that is monitored by Logger Pro software on the computer screen. If desired, an audible signal can also be obtained. The subject may then be stimulated in a variety of ways and the degree of stimulation measured graphically.

The GSR sensor can be used in bio-feedback studies in which the subject learns to control emotional state voluntarily by using relaxation techniques. This is often done with closed eyes while listening to the

audible signal from the GSR sensor. The pitch of this signal declines as skin conductivity decreases, allowing the subject to concentrate on, and monitor, the degree of relaxation. Alternatively, the subject can watch the graphical response on the computer screen while using relaxation techniques such as controlled breathing. Relaxation techniques with eyes open and eyes shut can then be compared.

As well as relaxation studies, the GSR sensor can also be used to determine the types of stimuli that excite various subjects. For example, the stimulatory or relaxing effect of different colours can be assessed, as well as the effects of various patterns and images.

To purchase

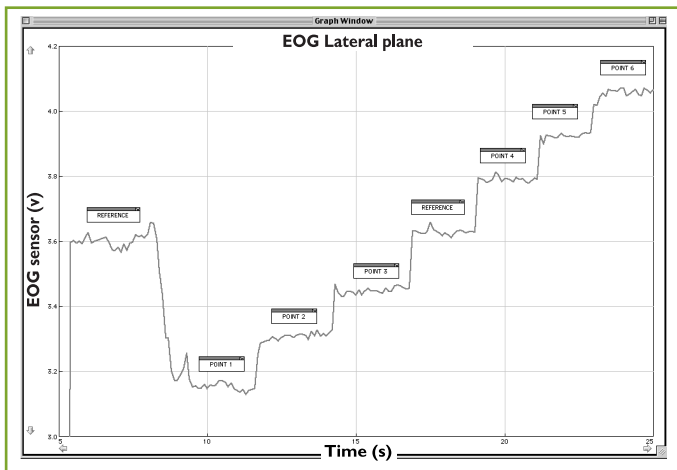
Galvanic Skin Response Sensor

Order #: S220

Price: \$475 US



Qubit
systems



Output from the EOG sensor as eyes are moved from left to right

EOG Sensor

Qubit Systems electrooculograph (EOG) sensor is used to monitor eye movement of a stationary subject. A reference electrode is placed on the forehead, electrodes are placed on the right and left temples for lateral eye movement detection, and above and below an eye for vertical eye movement detection. Lateral movement and vertical movement are plotted on different channels as voltages, or the EOG can be calibrated for each subject to provide angles of eye movement in both the horizontal and vertical plane. A convenient reset button allows the instrument to be zeroed when the subject is looking straight ahead.

Students are fascinated by the electrophysiology of muscles that control eye movement, and more so by the way in which our eyes track and scan objects. Numerous experiments are possible to determine how different subjects respond to different images. Show the subject an advertising poster and determine how the subject's eyes move to the most important features of the image. Advertisers use EOG devices in poster design. Show the subject a map and ask them to find a particular city, or a group of cities

with certain characteristics (e.g. population size). How effective is the legend of the map in helping the subject? How often is the legend consulted? Does the subject scan the map in a specific pattern or more irregularly?

Like the GSR sensor, the EOG sensor has applications in both physiology and psychophysiology laboratories, and is always extremely popular with students who wish to investigate how mind and muscle interact.

To purchase

EOG Sensor

Order #: S225

Price: \$725 US

Extras for Electrophysiology Sensors

Lab Pro Interface

Order #: C410

Price: \$275 US

Logger Pro Software

Order #: C901

Price: \$75 US

Package of 100 Disposable Electrodes

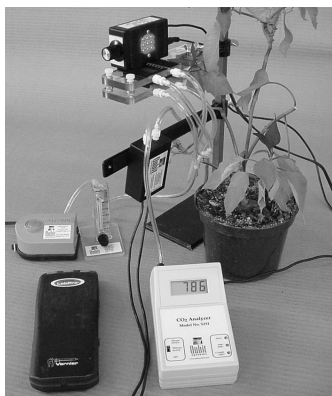
Order #: A263

Price: \$12 US



Qubit
systems

plant CO₂ analysis packages



The low-cost infrared CO₂ analyzer is available in a basic or advanced package. The advanced package is shown above.

Infrared CO₂ analysis for photosynthesis, respiration and photorespiration

Qubit Systems has developed an accurate, low-cost Infra Red CO₂ Analyzer that is ideal for teaching photosynthesis, respiration and photorespiration. It is also suitable for many research applications. The Infra Red CO₂ Analyzer forms the basis of our **Plant CO₂ Analysis Packages**. The packages also include all of the hardware and software required to perform accurate, open-flow gas exchange measurements.

Each package includes:

- Infra Red CO₂ Analyzer
- Flow-Through Leaf Chamber
- AC Gas pump
- Flow Meter with Control Valve
- Variable Light Source
- Laboratory Stand
- Analog to Digital Interface and Software

Choose from

- the Basic CO₂ Analysis package
- the Advanced CO₂ Analysis package
- the Field CO₂ Analysis package
- or select your own package components.

The Basic CO₂ Analysis Package

This package allows accurate measurements of photosynthesis, respiration and photorespiration at a fraction of the cost of research-grade instruments. The package includes:

- Infra Red CO₂ Analyzer
- Flow-Through Leaf Chamber
- AC Gas Pump
- Flow Meter with Control Valve
- Variable Halogen Light Source
- Light Sensor
- Light Filters
- Laboratory Stand
- Gas Bags
- Logger Pro or Serial Data Logger Data-Acquisition Software
- Customized Set-up Software
- Lab Pro or Serial Box Interface
- Instructor's and Student's Manuals with CD

Equipment set-up is swift and simple. The software is intuitive and easy to use. The manuals describe eight different experiments, each with full background information and data interpretation sections.

To purchase

Order #: CO500LP with Logger Pro and Lab Pro
Price: \$1855 US

Order #: CO500MAC for Macintosh
or CO500PC for PC with Data Logger and the
Serial Box Interface
Price: \$1700 US

The Advanced CO₂ Analysis Package

The package includes a Temperature/Humidity Sensor and substitutes an LED light source for the Halogen Light Source and Light Sensor. The LED Light Source supplies photosynthetically active radiation with minimum heat load. It has its own calibration file, providing measurements of irradiance at the leaf surface in units of $\mu\text{mol quanta}/\text{m}^2/\text{s}$. Approximately one thousand $\mu\text{mol quanta}/\text{m}^2/\text{s}$ are delivered at maximum output.

The package includes a template for the calculation of numerous gas exchange parameters including:

- photosynthetic rate
- transpiration rate
- leaf conductance
- internal CO₂ concentration

The package may be used with the two-channel Serial Box Interface and Data Logger Software. Alternatively, up to four sensors may be monitored simultaneously using our Lab Pro Interface and Logger Pro Software for Windows 3.1 or later, or Macintosh OS. Logger Pro software requires a Pentium or Power MAC computer. It has all the extra features typical of a Windows-based program.

To purchase

With Serial Box Interface and Data Logger software:

Order #: CO600MAC for Macintosh
or CO600PC for PC

Price: \$2,050 US

With Lab Pro Interface and Logger Pro Software:

Order #: CO650LP

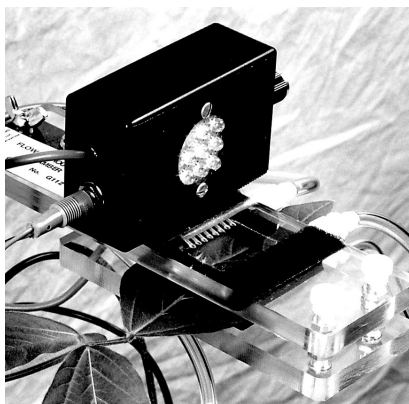
Price: \$2,286 US

The Field CO₂ Analysis Package

This is a compact, portable CO₂ analysis system for use with your lap-top computer. It contains everything required for

accurate measurement of CO₂ exchange in the field, including:

- Infra Red CO₂ Analyzer
- 8-hour Battery Pack and Charger
- DC Gas Pump
- Flow-Through Leaf Chamber
- Serial Box Interface and Software or Lab Pro Interface and Software



Flow-Through Leaf Chamber with LED Light Source

Optional additions include a temperature sensor, humidity sensor and LED light source. All sensors, the interface, the Infra Red CO₂ Gas Analyzer, the LED Light Source and the DC Pump may be powered simultaneously by the battery pack for up to eight hours of continuous operation before recharging is necessary. The Lab Pro Interface has its own internal battery and can collect and store data in the field without a computer.

As with all Qubit Systems' CO₂ Analysis packages, customized set-up software is provided for display and calibration of each sensor. In addition, a calculation template is supplied to facilitate the calculation of CO₂ exchange parameters.

To purchase the field CO₂ Analysis Package

With Serial Box Interface and Data Logger Software:

Order #: CO700MAC for Macintosh or

CO700PC for PC Price: \$1,904 US

With Lab Pro Interface and Logger Pro Software:

Order #: CO750LP

Price: \$2,081 US

Customized CO₂ Analysis Packages

All the components of our CO₂ Analysis packages are available for sale individually.

Infra Red CO₂ Analyzer:

Order #: S151 Price: \$995 US

LED Light Source:

Order #: A113 Price: \$295 US

Temperature/Humidity Sensor:

Order #: S161 Price: \$295 US

Thermistor for Flow-Through Leaf Chamber

Order #: S171 Price: \$295 US

Temperature Sensor:

Order #: S131 Price: \$30 US

Light Sensor:

Order #: S141 Price: \$140 US

Flow-Through Leaf Chamber:

Order #: G112 Price: \$120 US

AC Gas Pump:

Order #: G101 Price: \$60 US

DC Gas Pump

Order #: G103 Price: \$295 US

Flow Meter

Order #: G152 Price: \$60 US

Battery Pack with Charger

Order #: A242 Price: \$295 US

30 Liter Gas Bags (2)

Order #: G122 Price: \$60 US

Serial Box Interface

Order #: C101 Price: \$145 US

Lab Pro Interface

Order #: C410 Price: \$275 US

Data Logger Software for Macintosh

Order #: C801MAC Price: \$50 US

Data Logger Software for PC

Order #: C801PC Price: \$50 US

Logger Pro Software (cross platform)

Order #: C901LP Price: \$75 US

Instructor's and Student's Manuals for Logger Pro packages (with CD)

Order #: M/C 863 & 864 Price: \$70 US

Instructor's and Student's Manuals for Data Logger packages (with CD)

Order #: M/C 861 & 862 Price: \$70 US

About our manuals

The Instructor's Manual includes detailed information on every aspect of the CO₂ analysis packages. In both the Instructor's and Student's Manuals, background information is provided for each of the eight experiments described and protocols are presented in a logical and precise manner. Data analysis sections introduce students to numerous photosynthetic parameters including:

- carboxylation efficiency
- CO₂ compensation point
- photochemical efficiency
- light and CO₂ saturation kinetics

All experiments may be adapted for students at different levels, and a CD is provided for easy editing.

word of mouth

"I have been very impressed with the value and quality of our Qubit Systems' laboratories. Their simplicity of design allows students to understand the processes they are measuring better than our more elegant and expensive portable photosynthesis machine.

We plan to take your CO₂ system, with portable pump and battery, to the tropics this spring for use in a field course - a trip we are not brave enough to take our \$18,000 machine on!

Dr. Judy Parrish
Milliken University,
Decatur, Illinois



Qubit
systems

chlorophyll fluorescence package

The concept

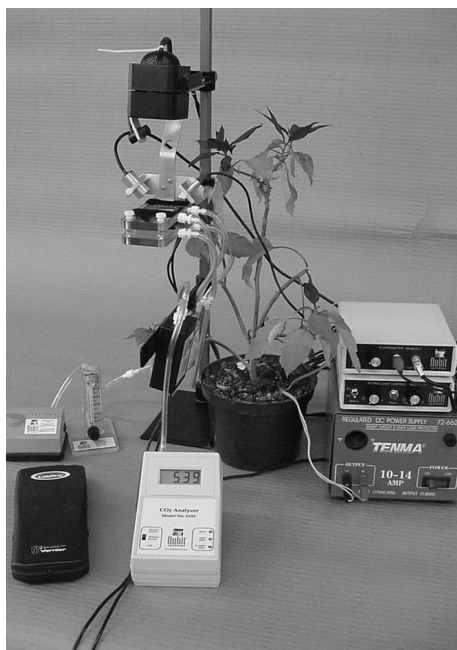
Measurement of chlorophyll fluorescence has become a standard method for investigating photosynthetic characteristics of plants. However, the cost of chlorophyll fluorometers has placed them beyond the budget of most undergraduate laboratories. The introduction of Qubit Systems' new **Chlorophyll Fluorescence Package** solves this problem, opening up a world of novel and exciting investigations at an affordable price.

Unlike other low-cost fluorometers, Qubit's instrument can be used in conjunction with CO₂ analysis systems, such as Qubit Systems' Plant CO₂ Analysis Packages. This expands the scope of potential investigations greatly, allowing rapid measurements of fluorescence kinetics and longer term studies of the interactions between the light and dark reactions of photosynthesis. Like most of Qubit Systems' other products, the components of the Chlorophyll Fluorescence Package have specifications suitable for many research applications.

Procedure

The Chlorophyll Fluorescence Package uses a pulse-modulated LED to excite chlorophyll fluorescence. A separate halogen lamp provides the actinic light that drives photosynthesis. The actinic light can be varied from 0-2000 $\mu\text{mol}/\text{quanta}/\text{m}^2/\text{s}$ for continuous irradiance of the leaf, and can provide saturating pulses of light greater than 5000 $\mu\text{mol}/\text{m}^2/\text{s}$. These saturating pulses fully reduce photosynthetic electron carriers and allow measurement of F_m and F'_m in dark-adapted and illuminated leaves, respectively.

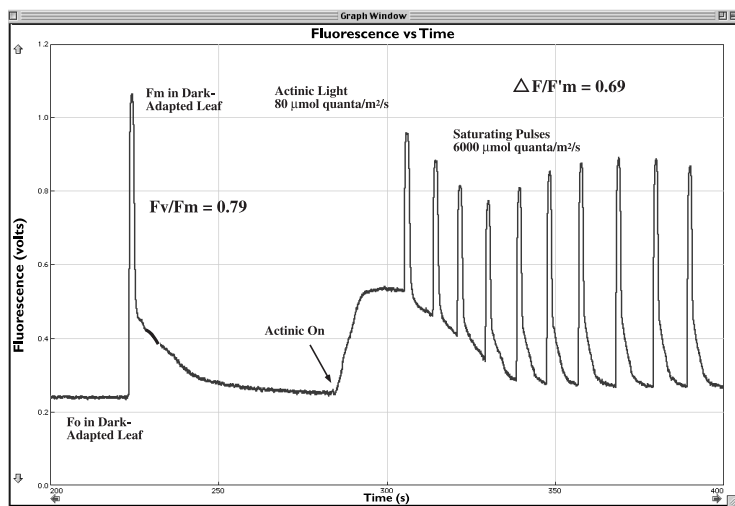
Attached or detached leaves may be used in experiments. For rapid measurements, the leaf



Chlorophyll Fluorescence Package shown with the S151 CO₂ Analyzer

is held in a leaf clamp. For measurements involving CO₂ analysis, the leaf is enclosed in an optional Flow-Through Leaf Chamber. In both cases F_0 , F_m , F and F'_m are measured, and parameters based on these measurements (such as F_v/F_m) may be calculated easily. If leaves are held in the leaf clamp, it is possible to make fluorescence surveys of large numbers of samples quickly. Data collected from a dark-adapted soybean leaf are shown in the graph on page 18.

Chlorophyll Fluorescence Kinetics



Use of the optional Flow-Through Leaf Chamber (G112) and S151 Infra Red CO₂ Analyzer allows investigations into numerous aspects of photosynthetic physiology. When the leaf is enclosed in a leaf chamber, its environment may be varied while the effects on fluorescence and CO₂ fixation are measured simultaneously. Qubit Systems manufactures a Leaf Temperature Thermistor (S171) and a Humidity/Temperature Sensor (S161) for monitoring the leaf's environment and for measuring transpiration.

This system may be used to study relationships between fluorescence and photosynthetic CO₂ fixation with variations in external and intercellular CO₂ concentration, irradiance, leaf conductance, temperature, transpiration rate and other environmental and physiological conditions.

The Fluorescence Package Features

- LED chlorophyll excitation light (660 nm peak)
- Halogen actinic light
- 0-2000 $\mu\text{moles quanta/m}^2/\text{s}$ continuous light at 300-700nm

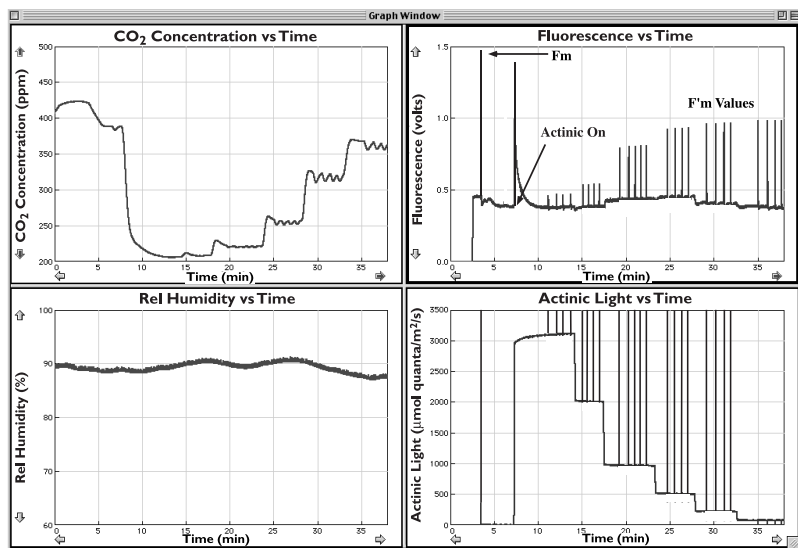
- 5000 $\mu\text{moles/m}^2/\text{s}$ saturation pulse
- automatic and manual saturating pulse control
- real-time graphing of fluorescence data
- rapid fluorescence measurements using the leaf clamp
- simultaneous CO₂ analysis using an optional leaf chamber and S151 CO₂ Analyzer

Experiments

Numerous laboratory studies may be conducted with the Fluorescence Package, either with or without simultaneous CO₂ analysis. These include:

- analysis of fluorescence kinetics
- effects of varying irradiance
- effects of varying CO₂ concentration
- investigations of photoinhibition
- effects of water stress
- effects of herbicides and photosynthetic inhibitors
- identification of photosynthetic mutants

CO₂ Response Graph



The data above show the results of an experiment in which fluorescence was measured in a dark-adapted leaf at different actinic light levels. Vertical spikes on the actinic light response graph correspond to saturating pulses of 5000 $\mu\text{mol quanta/m}^2/\text{s}$. These pulses allow for measurements of Fm and F'm. They also cause the oscillations seen in the CO₂ response graph.

The Fluorescence Package includes

- Pulse Modulated Chlorophyll Fluorometer with Fluorescence Detector and Excitation LED
- Fluorometer Ground Cable and AC Adapter
- Actinic Halogen Light Source with Actinic Light Control Module, Power Supply and Halogen Bulb Assembly
- Leaf Clamp
- Laboratory Stand
- Serial Box Interface or Lab Pro Interface
- Two-Channel Data Logger or Four-Channel Logger Pro Software
- Manual with CD

CO₂ analysis option

If you wish to collect CO₂ data and fluorescence data simultaneously, you should order the FL2 Chlorophyll Fluorescence Package and items from one of our CO₂ analysis packages. The Laboratory Stand, Logger Pro software and Lab Pro Interface are common components of the FL2 package and all of the Logger Pro Plant CO₂ Analysis Packages. If you wish, you may omit these items from your CO₂ Analysis Package order. This will reduce your CO₂ Analysis Package price by the cost of the individual items.

To purchase

with serial Box Interface and 2 channel Data Logger Software:

Order #: FL1MAC for Macintosh or
FL1PC for PC Price: \$ 2250 US

with cross-platform Lab Pro interface and
4 channel software:

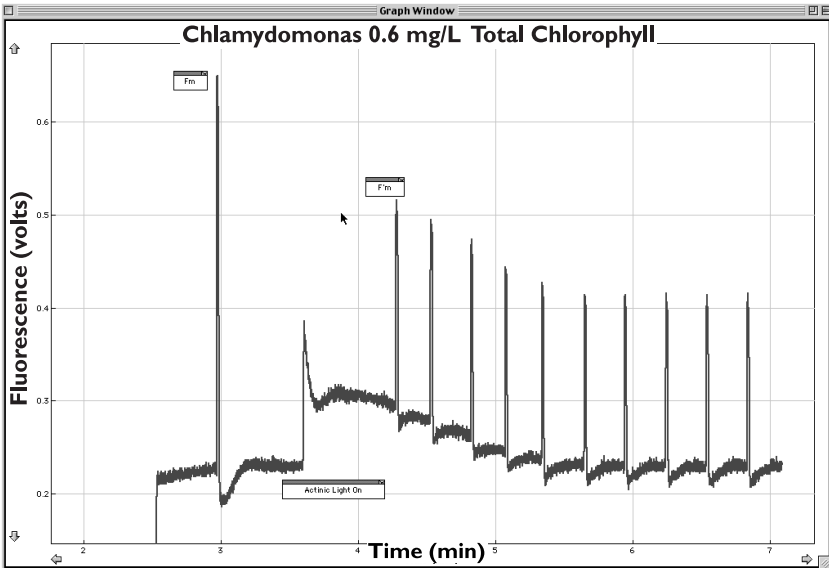
Order #: FL2LP Price: \$ 2495 US



Qubit
systems

algal fluorescence

Chlorophyll Fluorescence characteristics of chlamydomonas



Measurement of algal fluorescence using Qubit Systems' Fluorescence Package

As well as providing measurements of chlorophyll fluorescence parameters in leaves of higher plants, Qubit Systems' Fluorescence Package may also be used to measure these parameters in algal samples in the aqueous phase.

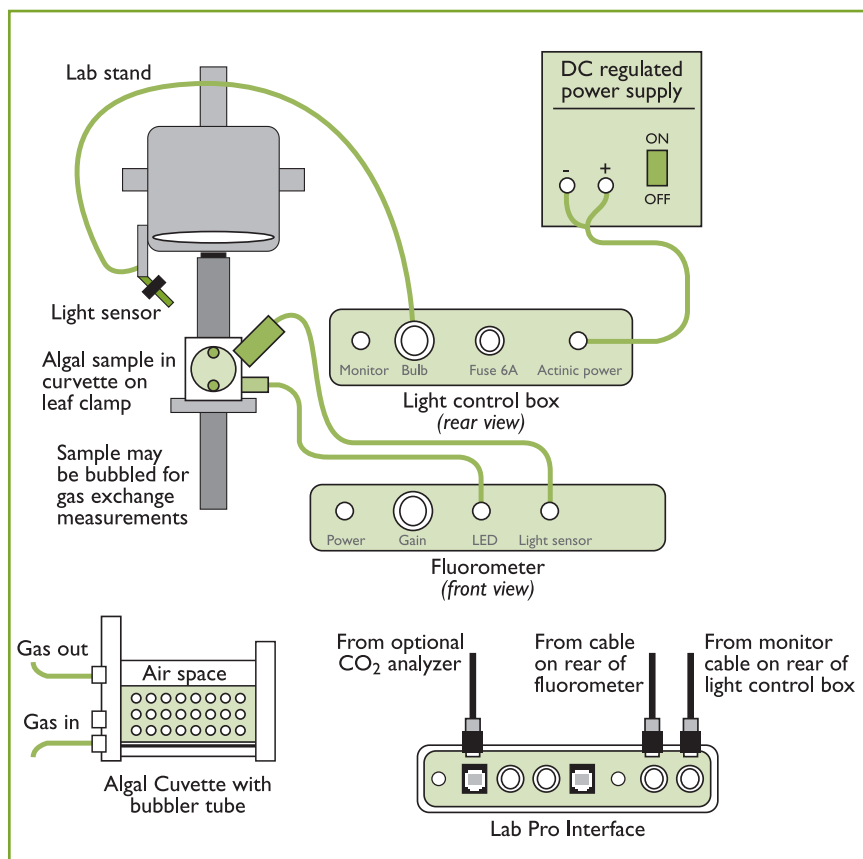
Algae are placed in a custom Qubit algal cuvette that is supported on the base of a leaf clamp. The LED chlorophyll excitation light is

placed below the photodiode that measures fluorescence and both are positioned close to the wall of the sample vial. Actinic illumination is provided from above by a 50 W halogen lamp that provides from 0 to 2000 $\mu\text{moles quanta PAR m}^2/\text{s}$ at the surface of the vial. The same lamp also provides a saturating flash of $>5000 \mu\text{moles quanta PAR m}^2/\text{s}$ for measurements of F_m and F'/m .

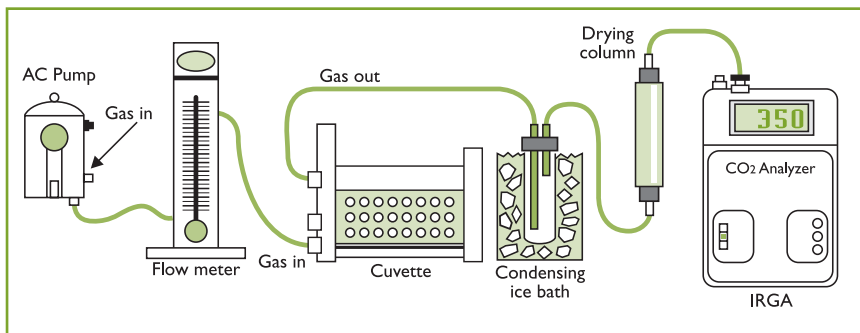
The data in the graph were collected using a sample of *Chlamydomonas* (0.6 mg/L total chlorophyll) maintained in the algal cuvette. These data allow for the calculation of quantum yield in the dark-adapted and illuminated condition, as well as the estimation of PS II electron transport rate, if the PAR incident on the sample is measured.

The sample in the algal cuvette may be bubbled during measurements of fluorescence with only a slight increase in the noise of the

fluorescence signal. Measurement of CO_2 concentration in the effluent gas stream using Qubit Systems' S151 CO_2 analyzer allow simultaneous determination of CO_2 exchange if the sample has sufficient photosynthetic activity. Also, it is possible to evaluate simultaneously the effects of changing environmental parameters and of adding metabolites or inhibitors on both the light and dark reactions of photosynthesis.



Configuration of system for measuring algal fluorescence



Optional gas exchange system for measuring algal CO₂ exchange

To purchase

For the simultaneous measurement of CO₂ gas exchange with the FL2 Chlorophyll Fluorescence Package in algal solutions, order the following kits:

Algal CO₂ Gas Exchange Kit with 10 ml Cuvette

Order #: FL22 Price \$1235 US

Algal CO₂ Gas Exchange Kit with 30 ml Cuvette

Order #: FL23 Price \$1245 US

The kits include:

Set of two Large Gas Bags

Order #: G122 price \$60 US

AC Powered Gas Pump

Order #: G101 Price \$60 US

30-240 ml Flow Meter with Valve

Order #: G153 Price \$60 US

Water Trap for Condensing Ice Bath

Order #: G212 Price \$12 US

Algal Cuvette

Order #: G213 (10ml or less) Price \$80 US

or G214 (30ml or less) Price \$90 US

Infra Red CO₂ Analyzer

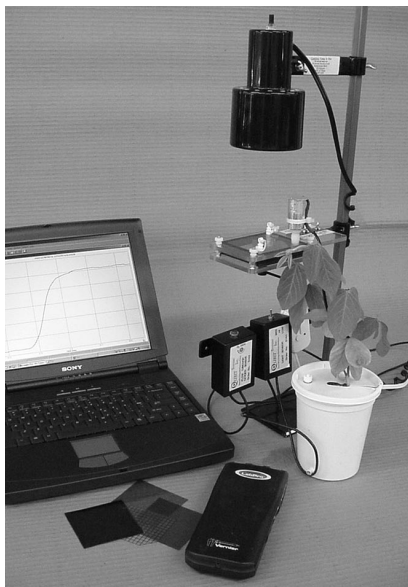
Order #: S151 Price \$995 US



photosynthesis package

The concept

Qubit Systems is proud to introduce a new concept in teaching photosynthesis in undergraduate laboratories. No more problems with algal systems and O_2 electrodes! No more antiquated Warburg paraphernalia! Our **Photosynthesis Package** measures photosynthetic rate in attached or detached leaves and displays experimental data to your computer screen in real time.



The Photosynthesis Package

The Photosynthesis Package includes everything you require to conduct numerous experiments investigating photosynthetic physiology. You supply only the computer and

the plant! Equipment specifications and experimental designs are fully documented in an Instructor's Manual. A separate Student's Manual guides undergraduates through experimental protocols and data handling. Minimal set-up time is required and experiments are easy to perform.

Procedure

A leaf is enclosed in a transparent chamber incorporating a sensor that measures photosynthetic O_2 evolution. Calibration of the O_2 sensor requires only that its output be adjusted to read atmospheric O_2 level (20.9%). The student fills a gas bag with exhaled air (approximately 17% O_2 and 3% CO_2), then pumps the air through the chamber. The chamber is then sealed and the leaf illuminated with a halogen light source. Chamber O_2 concentration increases as photosynthesis progresses.

word of mouth

"I highly recommend the photosynthesis package for any faculty member who wants to begin to make a laboratory more research-based and inquiry driven. It also is very useful to support independent research projects."

Dr. Jim Hoerter
Ferris State University
Big Rapids, Michigan.

Light level may be varied using a voltage regulator control. The light level used in the experiment is monitored by a light sensor situated beneath the leaf chamber. Light sensor output is given in $\mu\text{mol quanta}/\text{m}^2/\text{s}$ and no calibration is required.

Analog outputs from both the O_2 sensor and the light sensor are converted to digital signals by the Lab Pro Interface. Data are recorded and displayed to the screen using Logger Pro data-acquisition software. The software can also be used for subsequent data analysis. Note that we offer the option of using a two channel interface with DOS based Data Logger software for use with older computers.

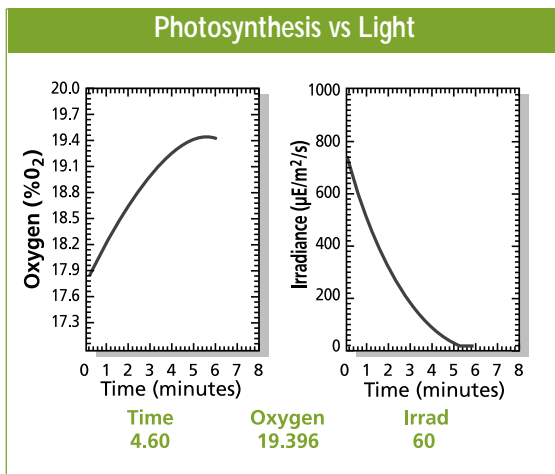
Students can display raw data on screen, or plot any two data sets against each other. For example, the graph below shows the

raw data from an experiment in which the leaf chamber O_2 concentration is monitored as irradiance is gradually reduced.

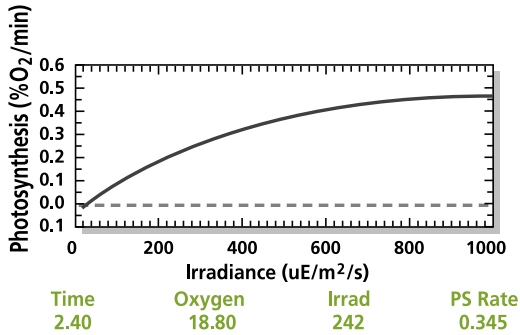
In the graph on the following page, the derivative of O_2 concentration against time has been calculated to produce a data set representing photosynthetic rate ($\% \text{O}_2$ increase per minute). This derivative has been plotted against irradiance to generate a photosynthetic light response curve.

Experiments

The Photosynthesis Package is suitable for use in both entry-level undergraduate courses and in research-based upper level courses. The Instructor's Manual provides step-by-step protocols for each experiment. It includes suggested variations to make experiments more, or less, challenging.



Photosynthesis vs Light



The experiments include investigations of:

- photosynthetic rate
- light compensation point
- light saturation point
- photochemical efficiency
- wavelength dependence of photosynthesis
- photoinhibition
- CO₂ limitation of photosynthesis
- comparison of sun and shade plants
- comparison of C3 and C4 species

Six different experiments are described in the manuals, together with background information and questions to aid in data interpretation.

The package includes

- Leaf chamber with O₂ sensor
- Light Sensor
- Halogen light source

- Power regulator
- Filters
- Laboratory stand
- Gas bags
- Lab Pro Interface or optional 2 channel Serial Box Interface
- Logger Pro software or optional DOS based Data Logger Software
- Student's manual (with CD)
- Instructor's manual (with CD)

To purchase

Order #: PH1LP for Macintosh and PC
(Lab Pro Interface and Logger Pro Software)
Price: \$1100 US

or

Order #: PH1Mac for Macintosh PH1PC for PC
(Serial Box Interface and Data Logger Software)
Price: \$945 US

dissolved oxygen package

The concept

Qubit Systems' package for measuring dissolved O_2 has features shared by no other polarographic O_2 monitoring system. The O_2 electrode may be used as a probe to measure dissolved O_2 in any aqueous medium, or it may be connected to a water-jacketed cuvette for measurements of O_2 consumption or production by biological samples or enzymatic reactions. Calibration is a simple two-point process, and all the requirements for calibration are supplied as part of the package.

For many O_2 electrodes, changing the membrane is a tedious and awkward process. Not so with Qubit Systems' O_2 probe. The membrane is an integral part of a membrane cap that screws onto the end of the probe, and requires only seconds to change. A spare membrane cap is provided as part of the package, and additional membrane caps may be ordered.

The O_2 electrode has built in temperature compensation so that calibration can be conducted in the lab and then the probe used in the field without the need for recalibration or tedious temperature correction calculations. Using Logger Pro or Data Logger software, the O_2 electrode may be calibrated in units of mg O_2 /L, % dissolved O_2 , ppm, or whatever units are appropriate to your study.

Optional extras for the dissolved O_2 package include a thermistor that monitors the temperature of the aqueous sample within the cuvette, a variable light source for illuminating photosynthetic samples, a light sensor for measuring irradiance levels, and syringes for introducing solutions into the cuvette during an experiment.

Applications

The dissolved O_2 package may be used for any application that involves measurement of O_2 in aqueous solution. It can be used remotely for measurement of O_2 concentrations in rivers and lakes, or it can be used in the laboratory to measure O_2 consumption or uptake by living organisms.

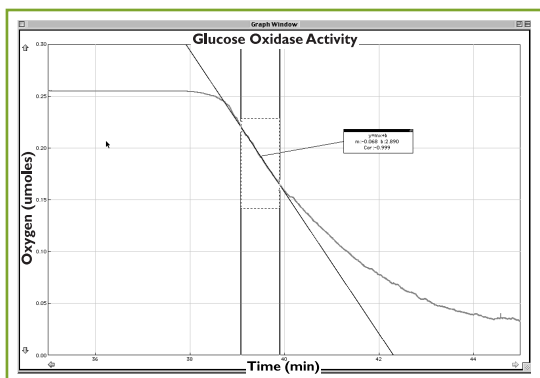
Experiments include:

- measurement of biological oxygen demand
- measurement of photosynthetic O_2 evolution in aquatic plants
- effect of inhibitors on mitochondrial electron transport
- effects of temperature on O_2 uptake by aquatic plants
- kinetics of O_2 -consuming enzymes

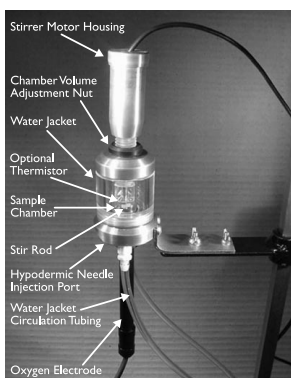
The dissolved O_2 package is a perfect complement to Qubit Systems' Respiration, Plant CO_2 Analysis and Photosynthesis Packages. While these packages are designed to measure the exchange of respiratory and photosynthetic gases in the gas phase, the O_2 electrode allows similar measurements to be made on aquatic organisms, and also on isolated organelles, such as mitochondria and chloroplasts.



The O_2 electrode probe and amplifier box



Measurement of glucose oxidase activity using the dissolved O_2 package



The O_2 probe integrated with the sample chamber

Of course, like all Qubit Systems' Laboratory Packages and sensors, the O_2 electrode may be used with either Logger Pro or Data Logger software and with the Lab Pro or Serial Box Interface. For field studies, the Lab Pro interface is strongly recommended.

The Dissolved O_2 Package includes:

- O_2 electrode probe
- Water-jacketed cuvette
- Lab stand and attachment bracket
- Electrolyte filling solution
- Calibration solution
- O_2 membrane caps
- Laboratory manuals for Students and Instructors
- Logger Pro Software and Lab Pro Interface or Data Logger Software and Serial Box Interface

Optional components include:

Thermistor to measure cuvette sample temperature

Order #: S172

Price: \$195 US

Syringes for addition of metabolites to cuvette

Order #: 10 μ L syringe A141

Price: \$40 US

Order #: 50 μ L syringe A143

Price: \$40 US

Order #: 100 μ L syringe A145

Price: \$40 US

Variable halogen light source

Order #: A111

Price: \$70 US

Light sensor

Order #: S141

Price: \$140 US

For users of older computers, we also provide a version of this package with a Serial Box Interface and Data Logger software. This will run on any 286 PC with a VGA monitor and two COM ports or Macintosh Classic or later model. The software is DOS for PCs and does not have the more sophisticated features of Logger Pro. However, it does have many of Logger Pro's mathematical functions. To order this option, use Order # OX1MAC for Macintosh or OX1PC for PC at \$1345 US.

To purchase

Complete Package

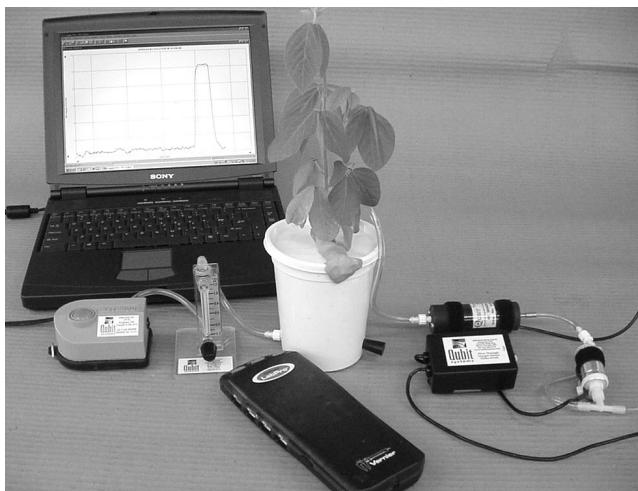
Order #: OX1LP

Price: \$1500 US



Qubit
systems

nitrogen fixation package



Nitrogen Fixation Package

The concept

Qubit Systems produces the only complete experimental package for measurement of nitrogen fixation in undergraduate laboratories. The unique flow-through H_2 sensor measures the production rate of H_2 from N_2 -fixing tissues, allowing *in vivo* measurement of nitrogenase activity in real time.

Measurement of H_2 evolution as a means of determining nitrogenase activity overcomes all the problems of the traditional acetylene reduction assay. It is perfectly safe, non-invasive and allows changes in nitrogenase activity to be observed as they occur.

The **Nitrogen Fixation Package** contains everything required to conduct numerous

investigations into the physiology and biochemistry of N_2 fixation; we even supply legume seeds and inoculum! You supply only the computer. Calibration of sensors is not necessary, set-up time is minimal and experiments are easy to perform.

Procedure

Nitrogenase activity is measured by monitoring H_2 evolution from N_2 -fixing material in an open-flow gas exchange system. Since H_2 is a natural product of the nitrogenase reaction, experiments are conducted under physiological conditions.

Gas of a known composition (usually air) is pumped through a sealed pot containing a nodulated legume root, or a cuvette containing

N_2 -fixing material (e.g. detached nodules). The flow rate of the gas is measured using a factory-calibrated flow meter. H_2 evolved from the nodules is monitored by a H_2 sensor. Other sensors are provided for measuring temperature and O_2 concentration.

Data is collected using the Lab Pro Interface. All sensor outputs are displayed to the computer screen using Logger Pro data-acquisition software. The software is also used for data analysis providing numerous functions for data acquisition, display, storage and mathematical manipulation.. Note that we offer the option of using a two channel interface with DOS based Data Logger software for users with older computers.

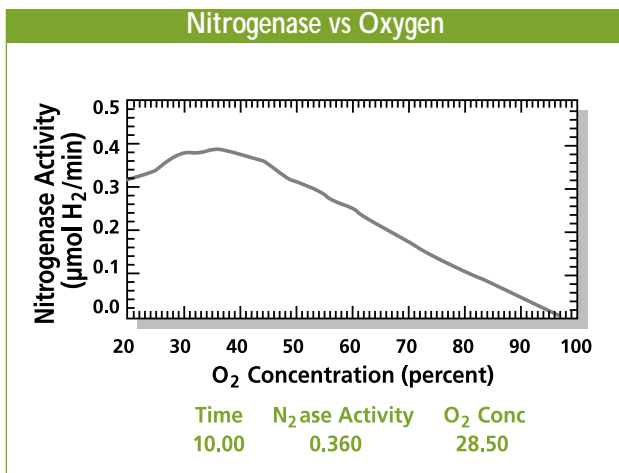
Unlike other methods of measuring nitrogenase activity, the H_2 evolution assay allows

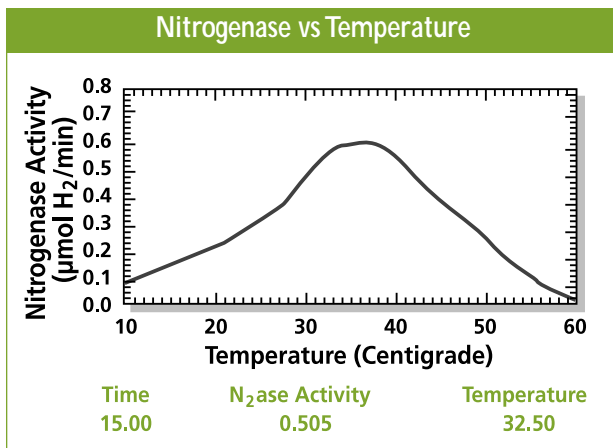
quantification of the different components of the activity. Total activity, N_2 fixation rate and activity related to H_2 evolution are all easily calculated, giving students a comprehensive view of the N_2 fixation reaction.

Experiments

Until the development of Qubit Systems' N_2 Fixation package, measurements of N_2 fixation and nitrogenase activity were neglected in the undergraduate laboratory curriculum. Now students can examine numerous aspects of this fundamental biological process.

For example, the following graph shows data from an experiment investigating the O_2 -lability of nitrogenase in an intact soybean plant.





In another experiment, students used H₂ and temperature sensors to examine aspects of nitrogenase kinetics:

In both examples, data were displayed to screen as the experiment progressed, an attribute not possible with any other method of measuring nitrogenase activity. The second experiment shows how the N₂ Fixation package may be used to investigate biochemical, as well as physiological, aspects of N₂ fixation.

The Package allows nitrogenase activity to be measured *in vivo*, without the need for tissue extraction and wet-lab procedures. Students can use the data from the temperature study to calculate Q₁₀ values and make Arrhenius plots.

The N₂ Fixation Package incorporates experiments suitable for students at all skill levels. The experiments include investigations of:

- temperature and nitrogenase activity

- oxygen regulation of N₂ fixation
- nitrogenase electron allocation coefficient
- N₂ fixation and photosynthate supply
- inhibition of N₂ fixation by fertilizers

word of mouth

“My students in plant physiology found the Qubit photosynthesis and nitrogen fixation systems challenging, enjoyable and rewarding.

The most heartening remark was: ‘Now we really begin to understand whole plant photosynthesis and nitrogen fixation, while before it was just meaningless book knowledge...’

Dr. Neil G. Grant
Professor, Department of Biology
William Paterson University
Wayne, New Jersey

The Student's manual provides step-by-step protocols for each experiment. The Instructor's manual includes suggestions to make experiments more, or less, challenging.

The manuals contain detailed background information about N_2 fixation. Each experiment is followed by questions to aid in data interpretation.

The package includes:

- Hydrogen sensor
- Oxygen sensor
- Temperature sensor
- AC gas pump
- Flow meter with control valve
- Gas bags
- Laboratory stand
- Plant pot cuvette and fittings
- Nodule cuvette and fittings
- Flow meter
- Desiccant column
- Soyabean Seeds and *Bradyrhizobium japonicum* Inoculant
- Lab Pro Interface or optional 2 channel Serial Box Interface
- Logger Pro Software or optional DOS-based Data Logger Software
- Student's manual (with CD)
- Instructor's manual (with CD)

Purchasers are assigned the unlimited right to copy software and manuals for use in their University Department.

About the Hydrogen Sensor

Qubit Systems' flow-through H_2 sensor is capable of measuring part-per-billion levels of H_2 in a flowing gas stream.

- measurement range: 0 to 2000 ppm H_2
- 0 to 5 V output to chart recorder or analog to digital interface
- DC power adapter provided

The Hydrogen Sensor may also be used to monitor the H_2 consumption of organisms that have the uptake hydrogenase enzyme.

To purchase

Order #: NF1LP for Macintosh and PC
(Lab Pro Interface and Logger Pro Software)
Price: \$1100 US

or

Order #: NF1Mac for Macintosh or NF1PC for PC
(Serial Box Interface and Data Logger Software)
Price: \$945 US

word of mouth

"We have used both the Photosynthesis and Nitrogenase assay systems and find them robust and easy to use.

An excellent feature is that the students can assemble the unit, get it working and then handle the data. This is a great boon from a teaching point of view in that the students feel that they are in control and they learn the real pitfalls in set up and data handling.

Qubit's educational packages are hard to beat. As tools for teaching students the principles of photosynthesis and nitrogen fixation, they are great value!"

Dr. Warwick Silvester
Dept. of Biological Sciences
University of Waikato
Hamilton, New Zealand

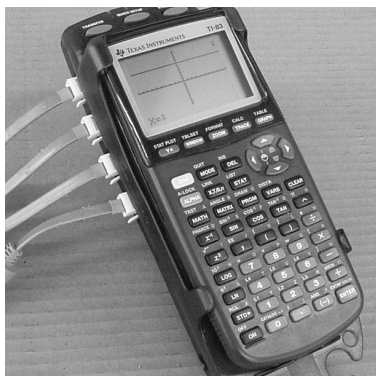
data acquisition

software & hardware

All Qubit Systems' laboratory teaching packages are shipped with your choice of Logger Pro or Data Logger software together with the new 4 channel Lab Pro Interface or a 2 channel Serial Box Interface. The award-winning software delivers sophisticated data acquisition and manipulation capabilities at an unbeatable price. It is so simple to run that even first-year students are able to collect, store, analyze and graph their data successfully with minimal assistance. Your software purchase includes the right to make unlimited copies for use within your department.

The Lab Pro Interface

The Lab Pro Interface provides four channel data acquisition in a sleek hand held design. It may be used with a PC or Mac computer, a Texas Instrument (TI) graphing calculator or as a stand-alone data logger when configured with Logger Pro software (sold separately). Lab Pro is supplied with



The Lab Pro Interface coupled with a TI graphing calculator

Data Mate software for communicating with a TI calculator, a calculator link cable and a calculator cradle for holding the interface and the calculator together as a convenient hand-held device.

Lab Pro can record data from up to 4 of Qubit System's analog sensors at the same time, and can record at speeds from 50 000 points per second to 1 point per day. Lab Pro comes with a USB cable as well as serial cables for both Macintosh and PC computers. For more information about Lab Pro see the sections on Logger Pro software.

To Purchase

Lab Pro Interface

Order # C410 (Macintosh and PC)

Price: \$275 US

Logger Pro

Our standard software package supporting both the 4-channel Lab Pro Interface and the 2-channel Serial Box Interface, Logger Pro represents the best value in data acquisition software, having features of software packages that sell for many times its price:

- up to four channels monitored and displayed simultaneously
- colorful, easy-to-read display
- sophisticated analysis tools including statistics, curve fitting, integration, and calculated channels for real time data conversion
- multiple data runs
- support for remote data collection and retrieval when used with the Lab Pro interface



Qubit
systems

PC users require Windows 95 or later, a Pentium processor or equivalent, 16MB of RAM, 10 MB of hard disk space and an available serial or USB port. Windows 3.1 users should contact us for specifications. MAC users require a PowerMac, G3 or G4 processor, System 7.6.1 or later, 16 MB RAM, 10 MB hard disk space and an available serial or USB port (USB requires OS 8.6 software). Both the Serial Box Interface and the Lab Pro Interface can be used with all of Qubit's sensors, or with any sensor that has a 0-5 Volt output. Set up and calibration files are supplied with Logger Pro when purchased with Qubit Systems' sensors or laboratory packages.

To Purchase

Logger Pro Software:

Order # C901LP (Macintosh and PC)

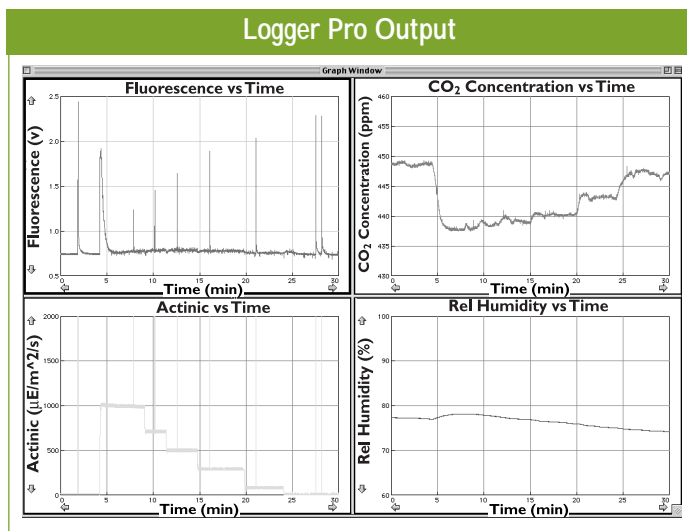
Price: \$75 US

Using Lab Pro in the field

The features of the Lab Pro interface means that it can be used to collect data without

being attached to a computer. There are two methods for collecting data with Lab Pro in the field. The first method involves setting up the interface with Logger Pro on your computer so that all the sensors are configured correctly for your experiment. Qubit Systems' set up files make this process very easy. You then remove the interface from your computer, configure your experiment in the field and collect data continuously, or as discrete sample points. In continuous mode the interface can log 12,000 data points. If configured for discrete data logging it can collect 99 data points. When the experiment is complete, the interface is reattached to your computer and data is download to Logger Pro or a spreadsheet program for display and analysis.

The second way of collecting data in the field allows several different data files to be stored in the Flash memory of a Texas Instruments TI-83 Plus graphing calculator or in the archival memory of the Lab Pro Interface itself.



Data collected from four sensors using Logger Pro Software

Data Logger

Superb, low cost data acquisition software that will run on a 286 PC and even a Mac Classic. Turn your obsolete computers into laboratory workstations! Data Logger is designed for the 2-channel Serial Box Interface with two analog inputs. While less sophisticated than Logger Pro, it has many similar features including:

- data channels monitored simultaneously
- up to four graphs displayed simultaneously
- both raw data and calculated data displayed in real time
- many data analysis functions such as curve fitting, regression and derivitization
- graph, print and zoom in features

Data Logger and the Serial Box Interface are the perfect choices for users with low budgets who wish to move away from archaic strip chart recorders into the digital era. As with Logger Pro, Qubit Systems provides Data Logger set-up files and calibration files when the software is purchased with any of Qubit's sensors or lab packages.

To Purchase

Data Logger Software:

Order # C801MAC for Macintosh;

C801PC for PC

Price: \$50 US

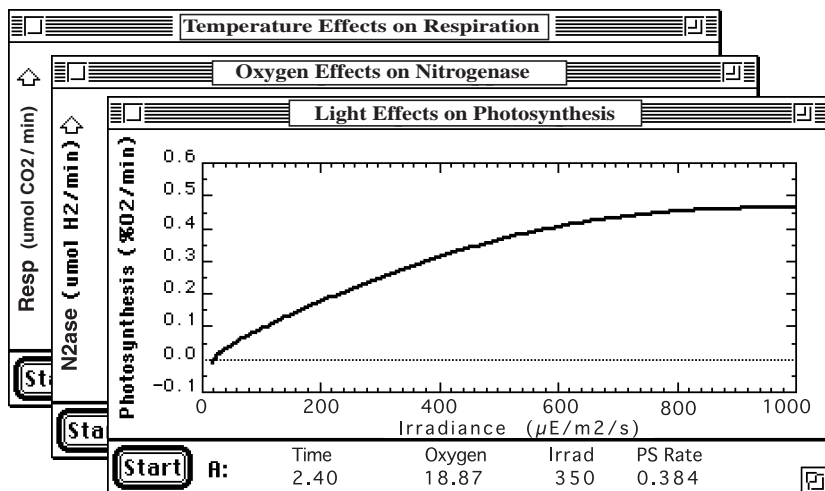
Serial Box Interface:

Order # C101MAC for Macintosh;

C101PC for PC

Price: \$145 US

Data Logger Output



Qubit's laboratory manuals

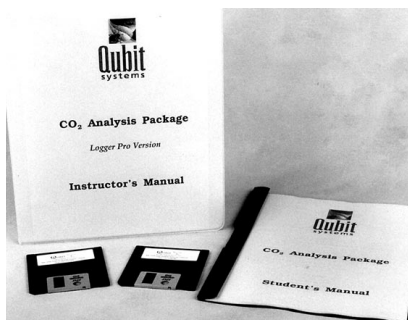
Qubit Systems' laboratory packages provide the instructor with everything required to conduct successful biological investigations, including detailed laboratory manuals. Complete Instructor's and Student's Manuals are part of each laboratory teaching package. All of the Instructor's Manuals include:

- the theoretical basis for the laboratory experiments
- a description of the function and operation of sensors and equipment
- simple instructions for the installation and use of software
- detailed calibration guides for all user-calibrated sensors and instruments
- experiments which have been student-tested in undergraduate laboratories
- additional notes to the instructor with suggestions for further experiments

The experiments are all designed to ensure that data collection and most data analysis can be completed within a standard three-hour laboratory session. They can easily be adapted for use by students from first-year to fourth-year levels. The experiments can also form the framework for independent student research projects.

Each experiment contains:

- an introduction to the theoretical basis of the experiment
- a comprehensive list of all of the equipment and supplies required
- a detailed description of equipment set-up procedures
- the full experimental protocol in point form
- clear, concise data analysis instructions
- blank tables for all recorded results
- a set of questions, with answers supplied in the Instructor's Manual



The Student's Manuals omit the Instructor's Notes and the answers to the questions at the end of each experiment, but they otherwise contain all of the information required for the students to run the experiments with minimal assistance.

The manuals are supplied in binders and in electronic form on CD. Your purchase price includes both the print and CD versions of the manuals. You have the right to make as many copies as you wish, for use in your University Department. You also have the right to edit the CD versions of the manuals to suit your curriculum.

To purchase

Consult the product list for the order numbers and prices of specific manuals.

infrared CO₂ analyzers

Qubit Systems manufactures a range of accurate, low-cost Infra Red CO₂ Analyzers that have numerous biological and environmental monitoring applications. Use our CO₂ analyzers to measure:

- *photosynthesis in vascular and non-vascular plants*
- *respiratory CO₂ fluxes in insects, amphibians, reptiles and small mammals*
- *CO₂ exchange from roots, soil samples, yeast colonies and other microorganisms*
- *CO₂ content of exhaled breath in humans*
- *atmospheric CO₂ concentration*

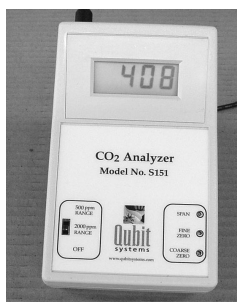
The analyzers are easy to use and are perfect for classroom applications, yet they have the accuracy and reliability required for many research purposes. All of the analyzers have the following features:

- *digital display*
- *analog output ranges may be switched without altering values on the digital display*
- *0–5V analog output*
- *response time of approximately twenty seconds to 95% of the final response*
- *field portable*
- *compact (625g, 8cm x 9cm x 17cm)*
- *internal battery for sixty- to ninety-minute remote operation*
- *optional battery pack*
- *simple calibration procedure*
- *zero and span potentiometers*

An Infra Red CO₂ Analyzer is supplied with many of Qubit's laboratory packages. The packages also include software, a computer interface and all of the components needed to construct an open-flow gas exchange system.

S151 CO₂ Analyzer (0–2000 ppm range)

This analyzer has a resolution of one ppm CO₂. It is ideal for measuring CO₂ exchange in plant tissues, small organisms, and organisms that have low metabolic rates.



S151 CO₂ Analyzer

Applications include:

- *photosynthetic measurements*
- *respiration of roots and soil samples*
- *respirometry of insects and other invertebrates*
- *respirometry of small amphibians*
- *head-space analysis of cell cultures*
- *atmospheric monitoring and control*

Ranges may be switched between 0–500 ppm and 0–2000 ppm for a 0–5V analog output. Output is linear across this range. Measurements between 2000–10,000 ppm CO₂ are possible, but they fall in a non-linear range and are not shown on the digital display. The S151 CO₂ analyzer is included in the following Qubit laboratory packages:

- *Basic CO₂ Analysis Package (CO500)*
- *Advanced CO₂ Analysis Packages (CO600 and CO650)*

- *Field CO₂ Analysis Packages (CO700 and CO750)*
- *Low-Range Respiration Package (RP1)*

To purchase

Order #: S151

Price: \$995 US

S152 CO₂ Analyzer (0-3% range)

The S152 CO₂ Analyzer has a maximum range of 3% CO₂ and a displayed resolution of 0.01% CO₂ (100 ppm).

Applications include:

- *atmospheric monitoring of elevated CO₂ levels*
- *respirometry of small mammals and reptiles*
- *CO₂ exchange measurements in fermentation vessels*

Ranges may be switched between 0-3% and 0-1.5% CO₂ for an analog output of 0-5V. Calibration is linear across these ranges and only a single CO₂ calibration gas is required. The S152 CO₂ analyzer is an optional component of Qubit Systems' High-Range Respiration Package (RP2).

To purchase

Order #: S152

Price: \$1195 US

S153 CO₂ Analyzer (0-10% range)

The S153 CO₂ analyzer has a maximum range of 10% CO₂ and a displayed resolution of 0.01% CO₂ (100 ppm).

Applications include:

- *respirometry in mammals*
- *exhaled breath analysis in humans*
- *compost monitoring*
- *monitoring of anaerobic metabolism in yeast colonies*

Ranges may be switched between 0-5% and 0-10% CO₂ for an analog output of 0-5 V. The S153 CO₂ analyzer is a component of

the Human Physiology Package (HP1) and the High-Range Respiration Package (RP2).

To purchase

Order #: S153

Price: \$1195 US

Data acquisition

Data output from all our analyzers may be monitored conveniently using our four-channel Logger Pro software (C901LP) and Lab Pro Interface (C410LP), or our two-channel Data Logger software (C801 MAC or PC) and Serial Box Interface (C101 MAC or PC). Logger Pro is also compatible with the Serial Box Interface.

Pumps

Pumps available from Qubit Systems include the G101 AC-powered pump (minimum unrestricted flow rate of 1200 mL/min) and the portable G103 DC-powered pump for lab and field work (adjustable flow from 0-1500 mL/min).

Flow Meter

The 200-1200 mL/min Flow Meter with control valve (G152) is supplied with the CO₂ Analysis Packages, Animal Respiration and Human Physiology Packages. Flow rates greater than 650 mL/min are not recommended for use with the CO₂ analyzers, so the Flow Meter should be used in series with our pumps.

Battery Pack

Qubit Systems' 12 V DC Battery Pack and Charger (A242) provide fifteen hours of power for CO₂ analyzer operation in the field. Up to eight hours of power is available when the DC pump, computer interface and LED light source are used simultaneously.

gas-phase oxygen sensors

Qubit Systems' Gas-Phase O_2 Sensors provide accurate measurements of oxygen concentration from 0–100% with a resolution of 0.01% (100 ppm). The sensors can measure:

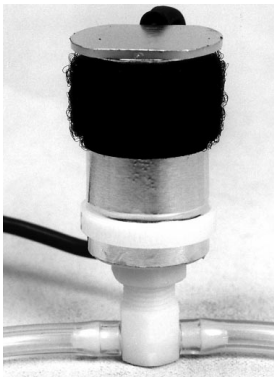
- O_2 consumption of invertebrate and vertebrate animals
- O_2 content of exhaled air in humans
- photosynthetic O_2 production
- atmospheric O_2 concentration
- O_2 consumption of colonies of microorganisms

S101 O_2 Sensor

- configured for diffusional O_2 measurement
- designed to be threaded into a sealed chamber to measure O_2 exchange integrated over time
- ideal for determining O_2 uptake in organisms with very low metabolic rates
- incorporated in the closed-system leaf chamber of our Photosynthesis Package (PH1)

S102 O_2 Sensor

- configured for flow-through applications and open gas-exchange respirometry systems



S102 O_2 Sensor

- ideal for determining O_2 uptake in large animals and animals with higher metabolic rates
- used for measuring the O_2 concentration of gas in collection bags
- included in our Respiration (RP1 and RP2), Human Physiology (HP1) and N_2 Fixation (NF1) Packages

Additional features of both the S101 and S102 Sensors:

- simple calibration requiring only atmospheric air
- output linear over the entire calibration range
- 90% response in twelve seconds
- output controlled by an adjustable gain
- output range adjustable from 0-25% = 5V to 0-100% = 5V
- temperature compensation circuit allows for changes in temperature during measurements without the need to recalibrate
- expected sensor life is three to five years
- replacement sensors are inexpensive

Power requirements

The O_2 sensor is a fuel cell that requires power only for amplification. When used with our Serial Box Interface (C101) or Lab Pro Interface (C410), power is supplied by the interface itself. For stand-alone operation, the A200 Sensor Power Supply is required to provide power to the amplifier and an analog output to your data acquisition system.

To purchase

Diffusion Mode O_2 Sensor

Order #: S101

Price: \$345 US

Flow-Through Mode O_2 Sensor

Order #: S102

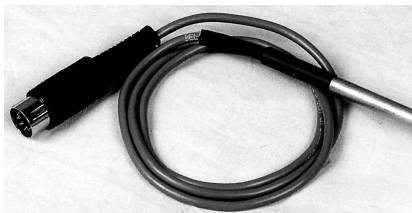
Price: \$345 US

temperature, humidity & pressure measurement

Temperature Sensor

- extremely durable
- rapid response
- may be used in solid, aqueous or gaseous media
- housed in a stainless steel tube, 10cm long, 6.4mm in diameter
- temperature range from -55°C to 150°C
- voltage output from 0-2 V
- analog output may be recorded by a chart recorder or analog-to-digital interface

The S131 temperature sensor is included in the Nitrogen Fixation (NF1) and Respiration Packages (RP1, RP2).



S131 Temperature Sensor

To purchase

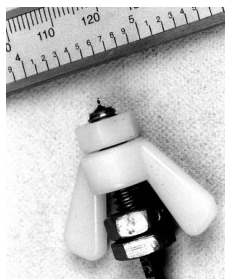
Order #: S131

Price: \$30 US

Leaf Chamber Thermistor

The thermistor measures leaf surface temperature very accurately and rapidly. It is essential for investigations into leaf CO₂ and water vapor conductance.

- 0.75mm-diameter sensor head
- housing screws into the base of the Flow-Through Leaf Chamber
- sensor position adjusts easily to touch leaf surface



S171 Leaf Chamber Thermistor

To purchase

Order #: S171

Price: \$295 US

Humidity/Temperature Sensor

Qubit Systems' combined humidity/temperature sensor allows simultaneous measurements of relative humidity and air temperature so that water vapor concentration may be calculated in absolute units. No calibration is required if used with Data Logger or Logger Pro software and the associated calibration files.

- 0–100% relative humidity measurement range
- -50°C–100°C temperature range
- dimensions: Only 5cm x 8cm x 3cm

The S161 humidity/temperature sensor is ideal for measurements of transpiration in an open-flow gas exchange system. It is included in our Advanced CO₂ Analysis Packages (CO600 and CO650) for this purpose. It may also be used to investigate water loss from animals or to monitor temperature and humidity levels in environmental chambers.

To purchase

Order #: S161

Price: \$295 US



Qubit
systems

Absolute Pressure Sensor

The Absolute Pressure Sensor is a component of the Breathing Monitor in the Human Physiology Package (HP1) and of the Potometer (S191). It may also be used alone to measure atmospheric pressure.

- State-of-the-art monolithic silicon pressure sensor
- Response time 1 mS
- Pressure range 15-115 kPa
- Voltage output from 0-2 V
- Analog output may be recorded by a chart recorder or analog-to-digital interface

To purchase

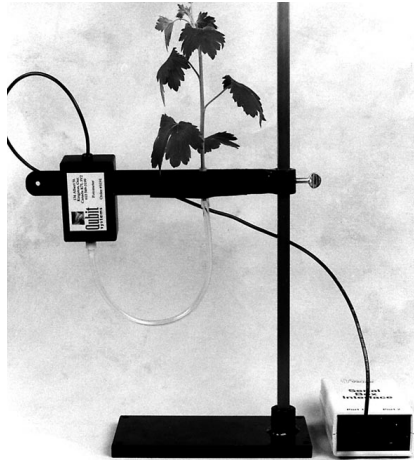
Order #: S181

Price: \$120 US

Potometer

The Potometer may be used independently or concurrently with Qubit's humidity/temperature sensor (S161) to measure changes in plant transpiration rate as environmental and physiological conditions are altered.

- pressure changes can be used to monitor relative rates of water uptake
- sensor may be calibrated to relate pressure changes to absolute rates of water uptake
- supplied with flexible vinyl tubing of two different diameters



Potometer

One end of a sealed vinyl tube is attached to the Potometer and the other end to the cut stem of a plant. The tube contains an air bubble in contact with the Potometer and an unbroken column of water in contact with the cut end of the plant stem. The air bubble expands as the plant stem draws the water up the tube. The absolute pressure sensor in the Potometer monitors the reduction in pressure within the air bubble. The potometer can also be configured for measurement of root pressure.

To purchase

Order #: S191

Price: \$120 US



Qubit
systems

light sources and sensors

You should consider the quality and quantity of light you require in your experiments before ordering a specific light source

LED Light Source

The LED light source is designed for use with Qubit Systems' Flow-Through Leaf Chamber (G112). The LED light source consists of a group of nine red LEDs mounted in a support that fits directly on the lid of the leaf chamber. The LED Light Source is DC powered and can be used in the field.

- *used in investigations of photosynthesis, respiration and photorespiration*
- *photon flux variable up to 1000 $\mu\text{mol quanta/m}^2/\text{s}$ PAR at the leaf surface*
- *no heat load on the leaf*
- *no separate light sensor required*
- *calibrated for read-out in units of $\mu\text{mol quanta/m}^2/\text{s}$ when used with Data Logger or Logger Pro software*
- *may be battery powered for field use*
- *peak wavelength of 660 nm \pm 10 nm*

The LED light source cannot be used for applications in which wavelengths outside the 650-670 nm range are needed. If a broader range of wavelengths is required, Qubit Systems' halogen light source may be used.

The LED light source is included in our Advanced CO₂ Analysis Packages (CO600, CO650).

To purchase

Order #: A113

Price: \$295 US

Halogen Light Source

The 50W halogen light source provides broad-spectrum white light. It uses AC power and is suitable for lab use.

- *used in investigations of photosynthetic O₂ and CO₂ exchanges*
- *maximum output of 1400 $\mu\text{mol quanta/m}^2/\text{s}$ when the light source is placed 11cm from the leaf chamber*
- *variable output when used with a separate Power Regulator (A112)*
- *special bracket supplied for mounting on Qubit Systems' Laboratory Stand (A101)*

Red, blue and green filters are part of Qubit Systems' Leaf Chamber Accessory Kit (A211). They all transmit similar quantum flux when used with the halogen light source.

To purchase

light source

Order #: A111

Price: \$70 US

Light Sensor

Qubit Systems' light sensor may be used in conjunction with the A111 halogen light source and Data Logger or Logger Pro Software to provide irradiance data in units of $\mu\text{mol quanta/m}^2/\text{s}$. Customized set-up and calibration files are available to users of Data Logger and Logger Pro software. The sensor may also be calibrated by the user for stand-alone operation or for relative measurements of light intensity.

- *selectable ranges (0-100, 0-300, 0-1150 $\mu\text{mol quanta/m}^2/\text{s}$) with calibrations for use under leaves or in direct halogen light*
- *0-4 V analog output to chart recorder or interface*
- *small surface area (2.4 x 2.8 mm)*



Qubit
systems

The sensor may be mounted directly under Qubit Systems' Flow-Through Leaf Chamber (G111) for use in photosynthesis measurements.

The Light Sensor is included in Qubit Systems' Photosynthesis Package (PH1) and Basic CO₂ Analysis Packages (CO500 and CO700).

To purchase

Order #: S141

Price: \$140

Sensor Power Supply

Except for the Infra Red CO₂ analyzers and the Hydrogen Sensor, Qubit's sensors do not require any power input when used with the Serial Box Interface (C101) or the Lab Pro Interface (C401). When used alone, they require a 5 V DC power input from Qubit's Sensor Power Supply.

The Sensor Power Supply has two female DIN sockets which provide 5 V DC to any two sensors simultaneously, and two cables to take the signals from these sensors to a chart recorder, or analog-to-digital interface.

Order #: A200

Price: \$85 US

Breath-Collection Bags

The 30L Breath-Collection Bags are made from heat-sealed, gas-impermeable, nylon polyethylene laminate. Each bag is supplied with a connector which attaches securely to the Breath Collection Valve Assembly. The Breath-Collection Bags are compact, light weight and durable.

To purchase

Order #: G124

Price: \$60 US for two.

Gas Bags

The 15L and 30L Gas Bags provide a stable source of air to a gas exchange system. They are made from heat-sealed, gas-impermeable, nylon polyethylene laminate. Each bag is supplied with a luer fitting, a length of vinyl tubing and a tube clamp.

To purchase

Small Gas Bags (15L)

Order #: G121

Price: \$50 US for two

Large Gas Bags (30L)

Order #: G122

Price: \$60 US for two

Qubitac Sealant

Do you ever need to:

- seal delicate plant tissue into a sample chamber without damaging it?
- stop leaks in gas exchange systems?
- immobilize items with a substance that will not adhere to them permanently?

Our Qubitac synthetic polymer compound will find hundreds of uses in your laboratory!

- soft, flexible and reusable
- gas impermeable and light opaque
- non-toxic
- adheres well to glass, rubber and plastic components of gas analysis systems without bonding to them permanently
- provides an air-tight seal around probes, stoppers and connections
- will not produce or consume CO₂, O₂, H₂, C₂H₂
- will not emit organic vapors that can interfere with gas sensor accuracy
- adheres well to plant tissue, yet may be removed easily without damaging the plant
- allows plants to grow normally while sealed

A small quantity of Qubitac is included in our Nitrogen Fixation Package (NF1) and our Respiration Packages (RP1 and RP2)

To purchase

Qubitac 1 kg container

Order #: G135

Price: \$55 US

Qubitac 2 kg container

Order #: G136

Price: \$105 US

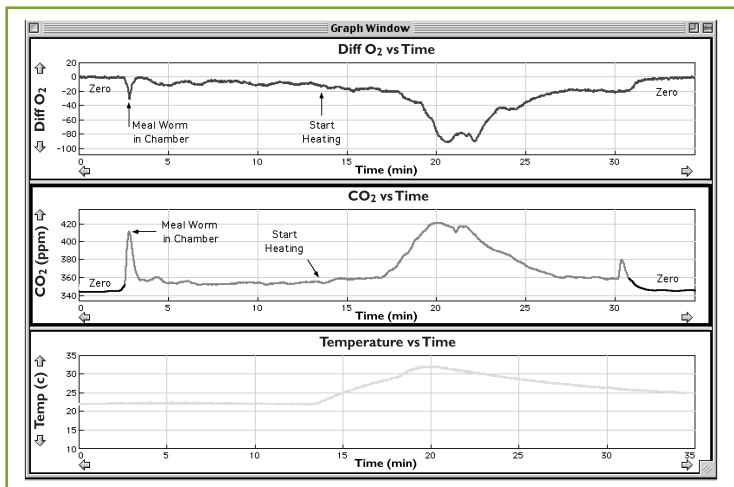
research instrumentation

As well as producing innovative, low cost laboratory packages for undergraduate biology education, Qubit Systems manufactures several gas analysis instruments, and complete gas exchange systems, for research purposes. These instruments have exceptional accuracy and stability, and are designed for stand-alone use or with sophisticated, multi-channel data acquisition systems, such as National Instruments LabView software.

Differential Oxygen Analyzer

Qubit Systems manufactures the world's only patented differential O_2 analyzer (DOX) with a resolution of $\pm 0.1\text{Pa } O_2$ against a background of air (20.9 kPa). This remarkable

instrument represents an unprecedented advancement in respirometry and photosynthesis research. For the first time researchers can measure real time rates of respiratory O_2 consumption from small insects, and photosynthetic O_2 production from intact leaves. When coupled with a CO_2 analyzer in an open gas exchange system, measurements of Gas Exchange Quotient ($GEQ = CO_2 \text{ exchange}/O_2 \text{ exchange}$) allow non-invasive investigations of respiratory metabolite determination, and analysis of reductant flow in anabolic and catabolic reactions.



Use of the differential oxygen analyzer for simultaneous measurement of O_2 and CO_2 exchange in a *Tenebrio molitor* larva (0.159g)

The preceding figure shows respiratory activity of a *Tenebrio molitor* larva (0.159 g) in a sample chamber with an 8 mL volume at a gas flow rate of 200 mL/min. Antiparallel oscillations in O_2 and CO_2 exchange rates reflect changes in respiration rate as elevated temperature increases metabolic rate and insect activity. At the lowest respiration rate in this example the S3A/DOX easily resolves an O_2 differential of 5 ppm. (that's 1.0 μL of O_2 per minute). Just imagine the possibilities this presents for your research!



The differential oxygen analyzer

The DOX has the greatest dynamic range of any gas analyzer on the market. In true differential mode it has ranges of ± 100 , ± 300 and ± 1000 Pa O_2 . In addition, both the reference and sample O_2 sensors can be monitored independently at the same time, and an automated Ref – Sample feature provides measurements of any O_2 difference. By choosing the appropriate range setting O_2 exchange can be measured with any animal from an insect to an elephant. Calibration is simple, extremely accurate, and is perfectly linear over the entire dynamic range of the analyzer.

Carbon Dioxide Analyzers

Qubit Systems' range of research CO_2 analyzers are designed for stand-alone use, or as part of our unique modular gas exchange system. Each is housed in a rugged metal case that can be linked with other components in similar cases for easy organisation of tubing and efficient organisation of lab space. The gas exchange system can be configured in numerous ways, and when linked together can be carried as a unit from one site to another using convenient end plates with sturdy carrying handles. The CO_2 analyzers are supplied in 3 ranges.

S154 CO_2 Analyzer (0 - 2000 ppm)

Designed for measurements of respiration in small animals and insects with low rates of CO_2 exchange. The analyzer may be used in flow-through gas exchange systems for real-time respiratory monitoring, or in semi-open and closed systems for measurements at extremely low activity levels.

Features include:

- switchable ranges of 0 - 500 and 0 - 2000 ppm CO_2
- 1 ppm CO_2 resolution on digital display
- Non-dispersive infra red technology
- Modulated infra red light source: no moving parts
- 0 - 5V output at both range settings
- Optional battery pack for field use



The S154 CO_2 analyzer

The analyzer is a component of our modular gas exchange systems that can be customized to meet all your respirometry requirements. Its rugged features make it suitable for use in both the laboratory and the field.

To Purchase

Order #: S154

Price: \$4100 US

S155 CO₂ Analyzer (0 - 10%)

Designed for measurements of respiration in animals with larger CO₂ fluxes. Two range settings allow users to select the range they require when investigating animals with a wide range of respiratory rates.

Features include:

- 0.01% CO₂ resolution on digital display
- switchable ranges of 0-5% and 0-10% CO₂ for a 0-5 V analog output
- non-dispersive infra red technology
- modulated infra red source: no moving parts
- flow-through or closed-system operation
- optional battery pack for field use

To Purchase

Order #: S155

Price: \$4300 US



The S155 CO₂ Analyzer

S103 Oxygen Analyzer (0 - 100%)

A unique fuel cell oxygen analyzer for respiratory gas analysis and environmental O₂ monitoring. It allows the user to calculate respiratory quotient when used with our S155 CO₂ analyzer in an open gas exchange system. For rates of O₂ exchange in smaller or less active organisms it can be configured in a closed system.

Features include:

- 0.01% O₂ resolution on digital display
- switchable ranges of 0-25% and 0-100% O₂ over 0-5V
- atmospheric pressure sensor corrects %O₂ output as pressure changes
- output in units of %O₂ or kPa O₂
- optional battery pack for field use
- temperature compensated sensor

These features make the S103 the most flexible and accurate analyzer of its type. It is also among the least expensive O₂ analyzers available. The

fuel cell sensor is easily replaced by the user when necessary (approximately every two to three years). Replacements cost only \$150 US.

To Purchase

Order #: S103

Price: \$3500 US



The S103 O₂ Analyzer



Modular Gas Exchange system

Modular Gas Exchange Systems

Qubit Systems is proud to introduce a new concept in gas exchange technology that avoids the clutter common to many gas exchange systems. All of our analyzers, pumps and flow meters are housed in instrument cases that can be fitted together to form compact gas exchange systems with gas inlets and outlets in the most convenient locations to reduce tubing lengths. Any component can be attached to any other, so you may change your system configuration easily to meet your different experimental requirements. End plates with handles are provided for easy transport between labs or into the field. Components may be locked in place to provide added stability.

In addition to our analyzers, the modular components include:

- 0 - 1500 mL DC Gas Pump (P650) \$495 US
- 0 - 380 mL Flow Meter (F380) \$395 US
- 0 - 900 mL Flow Meter (F900) \$395 US
- 12VDC Battery Pack (4 outputs) \$395 US

For information about our digital mass flow monitors and mass flow controllers, as well as our computer controlled gas multiplexing systems, please contact Qubit Systems Inc.

Turn-Key Customized Gas Exchange Systems with LabView Software

Many researchers require a fully automated gas exchange system with easy to use equipment and software, multiple sample capability, on-the-fly calculations, and simple data management. Qubit's biologists have been designing and using such systems for over 20 years and have published their research extensively in top-ranked journals.

Qubit Systems now offers customized gas exchange systems for researchers in respirometry, photosynthesis, N_2 fixation, and any other application in which the exchanges of CO_2 and O_2 are measured.



Qubit
systems

Features of the systems include:

- *8 channel capability*
- *automated channel selection*
- *open Flow or Stopped Flow Measurements*
- *digital flow control and monitoring*
- *automated data acquisition and processing*
- *numerous options for analyzers and sensors*

Data acquisition and control is by National Instruments LabView software, the most advanced and flexible software for virtual instrumentation. The systems may be operated from either a lap-top or desk-top computer and do not require a dedicated computer for operation.

Please contact us if you have specific needs for a gas exchange system and we will provide you with free advice and a quote at your request.

It's guaranteed!

Qubit stands behind its product quality with confidence. We offer excellent customer service and would be happy to help you with any questions you may have. All of our products are fully guaranteed for two years. Should you decide to return any one of our products within 30 days, we will refund your money in full, including shipping charges.

Qubit Systems Inc. is always pleased to provide whatever technical or design support you require to obtain the best from your instruments. Our staff includes long-established research biologists who speak your language and who can advise you about many aspects of the use of gas exchange technology to study biological processes.



product line & price list

Item	Order Number		Price \$US
Laboratory Packages	Mac	PC	
The Low-Range Respiration Package	RP1LP	RP1LP	\$1925
The High-Range Respiration Package	RP2LP	RP2LP	\$2295
The Human Physiology Package	HP1LP	HP1LP	\$2425
The Basic CO ₂ Analysis Package			
-with Serial Box Interface & Data Logger	CO500MAC	CO500PC	\$1700
-with Lab Pro interface and Logger Pro	CO500LP	CO500LP	\$1855
The Advanced CO ₂ Analysis Package			
-with Serial Box Interface & Data Logger	CO600MAC	CO600PC	\$2050
-with Lab Pro Interface & Logger Pro	CO650LP	CO650LP	\$2286
The Field CO ₂ Analysis Package			
-with Serial Box Interface & Data Logger	CO700MAC	CO700PC	\$1904
-with Lab Pro Interface & Logger Pro	CO750LP	CO750LP	\$2081
The Fluorescence Package			
-with Serial Box Interface & Data Logger	FL1MAC	FL1PC	\$2250
-with Lab Pro Interface & Logger Pro	FL2LP	FL2LP	\$2495
Algal CO ₂ Kit			
-with 10 ml Cuvette	FL22	FL22	\$1235
Algal CO ₂ Kit			
-with 30 ml Cuvette	FL23	FL23	\$1245
The Photosynthesis Package			
-with Serial Box Interface & Data Logger	PH1MAC	PH1PC	\$ 945
-with Lab Pro Interface and Logger Pro	PH1LP	PH1LP	\$1100
The Nitrogen Fixation Package			
-with Serial Box Interface & Data Logger	NF1MAC	NF1PC	\$ 945
-with Lab Pro Interface and Logger Pro	NF1LP	NF1LP	\$1100
Dissolved Oxygen Package			
-with Serial Box Interface and Data Logger	OX1MAC	OX1PC	\$1345
-with Lab Pro Interface and Logger Pro	OX1LP	OX1LP	\$1500
Human Electrophysiology Package	HE1LP	HE1LP	\$2850

product line & price list

Item	Order Number		Price \$US
Manuals for Laboratory Packages	Mac	PC	
Instructor's Manual for Respiration Package	M/C891MAC	M/C891PC	\$40
Student's Manual for Respiration Package	M/C892MAC	M/C892PC	\$30
Instructor's Manual for Human Physiology Package	M/C952MAC	M/C952PC	\$40
Student's Manual for Human Physiology Package	M/C951MAC	M/C951PC	\$30
Instructor's Manual for Data Logger CO ₂ Analysis Packages	M/C861MAC	M/C861PC	\$40
Student's Manual for Data Logger CO ₂ Analysis Packages	M/C862MAC	M/C862PC	\$30
Instructor's Manual for Logger Pro CO ₂ Analysis Packages	M/C863MAC	M/C863PC	\$40
Student's Manual for Logger Pro CO ₂ Analysis Packages	M/C864MAC	M/C864PC	\$30
Instructor's Manual for Fluorescence Package	M/C200MAC	M/C200PC	\$40
Student's Manual for Fluorescence Package	M/C201MAC	M/C201PC	\$30
Instructor's Manual for Photosynthesis Package (DL)	M/C921MAC	M/C921PC	\$40
Instructor's Manual for Photosynthesis Package (LP)	M/C923MAC	M/C923PC	\$40
Student's Manual for Photosynthesis Package (DL)	M/C922MAC	M/C922PC	\$30
Student's Manual for Photosynthesis Package (LP)	M/C924MAC	M/C924PC	\$30
Instructor's Manual for N ₂ Fixation Package (DL)	M/C941MAC	M/C941PC	\$40
Instructor's Manual for N ₂ Fixation Package (LP)	M/C943MAC	M/C943PC	\$40
Student's Manual for N ₂ Fixation Package (DL)	M/C942MAC	M/C942PC	\$30
Student's Manual for N ₂ Fixation Package (LP)	M/C944MAC	M/C944PC	\$30
Instructor's Manual for Dissolved O ₂ Package	M/C351MAC	M/C351PC	\$40
Student's Manual for Dissolved O ₂ Package	M/C352MAC	M/C352PC	\$30
Instructor's Manual for Human Electrophysiology Package	M/C461MAC	M/C461PC	\$40
Student's Manual for Human Electrophysiology Package	M/C462MAC	M/C462PC	\$30

product line & price list

Item	Order Number		Price \$US
Computer Interfaces and Software	Mac	PC	
Serial Box Interface	C101MAC	C101PC	\$ 145
Lab Pro Interface (Cross Platform)	C410	C410	\$ 275
Data Logger Software	C801MAC	C801PC	\$ 50
Logger Pro Software (Cross Platform)	C901	C901	\$ 75
TI-83 Graphing Calculator	C204	C204	\$ 125
Graph Link Software and Cable	C208	C208	\$ 70

Sensors

Diffusion-Based Oxygen Sensor	S101	\$ 345
Flow-through Oxygen Sensor	S102	\$ 345
Dissolved Oxygen Electrode	S120	\$ 195
Hydrogen Sensor	S121	\$ 220
Temperature Sensor	S131	\$ 30
Light Sensor	S141	\$ 140
Infra Red CO ₂ Analyzer 0-2000ppm	S151	\$ 995
Infra Red CO ₂ Analyzer 0-3%	S152	\$1195
Infra Red CO ₂ Analyzer 0-10%	S153	\$1195
Humidity and Temperature Sensor	S161	\$ 295
Leaf Temperature Thermistor	S171	\$ 295
Dissolved Oxygen Cuvette Thermistor	S172	\$ 195
Potometer	S191	\$ 120
Absolute Pressure Sensor	S181	\$ 120
Wireless Exercise Heart Rate Monitor	S182	\$ 100
EKG Sensor	S205	\$ 375
EMG Sensor	S210	\$ 590
Hand Dynamometer	S215	\$ 350
Galvanic Skin Response Sensor	S220	\$ 475
EOG Sensor	S225	\$ 725

product line & price list

Item	Order Number	Price \$US
Gas Exchange Accessories		
AC Powered Gas Pump	G101	\$ 60
Flow Restrictors (3)	G102	\$ 36
DC Powered Gas Pump	G103	\$295
Dissolved Oxygen Electrode Cuvette	G110	\$550
Closed System Leaf Chamber	G111	\$100
Flow-Through Leaf Chamber	G112	\$120
Animal Chamber 2-cm I.D. x 10cm L	G113	\$ 50
Animal Chamber 8.5-cm I.D. x 15 cm L	G114	\$350
Animal Chamber 3.7-cm I.D. x 20 cm L	G115	\$ 75
Animal Chamber 14.5-cm I.D. x 40 cm L	G116	\$450
Small Gas Bags (2)	G121	\$ 50
Large Gas Bags (2)	G122	\$ 60
Breath Collection Bags (2)	G124	\$ 60
Qubitac Sealant		
1 Kg Container	G135	\$ 55
2 Kg Container	G136	\$105
Drying Column with Desiccant	G141	\$ 12
Desiccant (50g) for Drying Column	G142	\$ 6
Flow Meter (200 mL/min to 1200 mL/min)	G152	\$ 60
Flow Meter (30 mL/min to 240 mL/min)	G153	\$105
Nodule Cuvette	G161	\$ 6
Water Trap for Condensing Ice Bath	G212	\$ 12
10 ml (or less) Algal Cuvette	G213	\$ 80
30 ml (or less) Algal Cuvette	G214	\$ 90
Breath Collection Valve Assembly	G221	\$ 30
Breathing Monitor Belt	G224	\$ 85
Plant Growth Pots		
-with Lids, Tubing and Qubitac (4)	G131	\$ 24
-with Lids, Tubing and Qubitac (10)	G235	\$ 52
-with Lids, Tubing and Qubitac (40)	G236	\$198

product line & price list

Item	Order Number	Price \$US
General Accessories		
Laboratory Stand	A101	\$100
Halogen Light Source	A111	\$ 70
Voltage Regulator	A112	\$ 60
LED Light Source	A113	\$295
Filling Solution for O ₂ Electrode	A131	\$ 6
Calibration Solution for O ₂ Electrode	A132	\$ 6
Polishing Strips for O ₂ Electrode	A133	\$ 6
Membrane Caps for O ₂ Electrode	A134	\$ 18
10 - µL Syringe for Dissolved Oxygen	A141	\$ 40
50 - µL Syringe for Dissolved Oxygen	A143	\$ 40
100 - µL Syringe for Dissolved Oxygen	A145	\$ 40
Stirrer/Plunger Assembly for Dissolved Oxygen Cuvette	A148	\$275
CO ₂ Scrubbing Column	A241	\$ 12
Soybean Seeds and Bradyrhizobium japonicum Inoculant	B201	\$ 11
Sensor Power Supply	A200	\$ 85
220V/110V Voltage Transformer	A201	\$ 50
Leaf Chamber Accessories Kit	A211	\$ 12
Battery Pack and Charger for -Infra Red CO ₂ Analyzer	A242	\$295
Disposable Electrophysiology Electrodes (100/package)	A263	\$ 12

Prices do not include shipping and handling.

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